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此段測法稍有更易基綫及水準測量與前相同惟橫綫左右各長至八千尺而距離亦八千尺不若前之距離千尺長二千尺也沿基綫地形左右各測至六百尺

自屈家店至北塘基綫長約三十八英里其所經過之處除場河淀以上十里爲肥沃耕種地外餘皆卑濕窪下蘆葦叢生其產品皆爲燃料以供津埠之需此段地勢除場河淀中約較低二三尺外其餘皆爲平地於行水極不相宜將來若欲於此開闢入海新道是否可行誠一疑難之問題也

H綫爲第一隊測綫之終點與第二隊測綫之聯絡綫經過蘆運河下游此段頗多屈曲自北塘至漢沽沿河地勢極爲平坦

前項測量既竣該隊復續行測勘永定河由郭家務直接入海捷徑一綫此綫係奉 督辦訓令測勘並不在審查會建議之列此綫測量計分兩段

第一段由郭家務至漢溝 (I綫)

第二段由漢溝至蘆台入海 (II綫)

第一段歸第一隊勘測因該隊曾測三角淀熟習該地情形與上次所測不致重複

第二段正位於第一隊舊測之綫與蜈蚣河之間因蜈蚣河前經第二隊測過故令該隊擔任以資熟手且不致與舊點相混如此而金鐘河北蜈蚣河南一帶之地遍測無遺矣



是項測法兩隊相同其基綫以鋼鍊與水平儀精確測每百尺記數一次在基綫兩測之橫綫每長八千尺其水準每五百尺記數一次有時因地勢之關係酌爲增減

自郭家務以至北運河所有綫道直向東行計長三十二英里該地天然傾勢爲自西至東即自三角淀首端以達北運河至將近北運河三英里之地則大致均爲平坦因中間之地平並無突然之變易其高度差數在八千尺橫綫之中至爲細微未嘗超過二尺

郭家務至北運河傾勢當如左表

郭家務地平高度

六一

北河地平高度

一九

郭家務至北運河約計程三十英里於斯可見三十里中高底差度爲四十二尺地平斜坡約爲一與三五〇〇之比例第二段由第二隊在漢溝與廊園之間接第一隊之終點進測該綫起首五英里趨向東南所經之處爲空曠未經農事之地自此以往東向進行有二十英里之遙爲一平直綫觀察情勢該綫實具有自然之利益更有進者該一帶地價甚廉每畝約七元且該地悉爲蘆塘並無貴重財產足阻購地進行者地勢極爲平坦試取其中間兩地而推測其高度之差數當不過二尺該綫在二十英里處經過七里海之南部

七里海昔爲一湖沼
年久淤積遂成平陽

繼續向東行過東引河（青龍灣尾閘）與蘆運河（箭桿河尾閘）

至漢沽經過京奉路綫復由此傾向東南進行經由漢沽之鹽場而達海全綫所經之處其地平坦間有高下然爲勢甚微自北運河達海一段之地除起首二英里外餘無傾勢之可言

茲將全綫高度列表如左

起點處堤頂之高度	二八、四二
一里 處地平	一五
五里 處地平	八、二七
十里 處地平	七、五四
十五里 處地平	九、〇五
二十里 處地平	八、五三
二十五里 處地平	七、五一
三十里 處地平	七、九九
三十五里 處地平	一〇、七八
四十里 處地平	九、五三
四十五里 處地平	九、一二

四十八里在海岸終點處

四·九四

觀於上列之表當知自北運河達海一帶絕無天然之斜坡此層在永定河新尾閘計畫中當不可忽視

北運河

第二隊測量係以現在籌劃中之牛牧屯開關工程左近爲起點牛牧屯係一小村其位置在箭桿北運兩河之間在通州東南約八十里

查此項開關工程計劃最初爲海河工程局所建議當民國二年李遂鎮決口後北運之水竟由箭桿河入蘄運河不復由海河入海而箭桿河身狹小兩岸又無堤防因之該河附近諸區悉遭淹浸當事者但知堵決以救急而未籌永久之計劃遂致次年李遂重決溢流成渠一切設施竟難收效接引北運上游之水仍歸海河其利非止一端一則可以防止箭桿河左右之被災一則可以維持海河港內之航路人盡知海河賴五河之水以利航行而未知海河實未盡受五河之益蓋五河之水大都挾帶泥沙大沽海口逐漸淤高疏濬之費歲頗不貲五河之中惟北運挾沙最少尙可用以衝刷淤積海河工程局疊次籌劃引北運復歸海河者亦職是故民國五年政府曾以鉅款在李遂鎮築壩以防北運東溢乃去歲洪水發生李遂鎮新壩仍被沖決今欲引北運仍歸海河則唯有開關牛牧屯新河一法蓋牛牧屯附近箭桿北運兩河河底高度不相上下新河開關後可使北運已入箭桿河之水由此仍入北運也

該隊測綫起於牛牧屯相近處沿箭桿河進行約三英里復於箭桿河及北運河之間測勘兩道最短綫以備他日擇尤施工所有測量綫當自牛牧屯至河西務又由青龍灣減河口至潘莊由潘莊順蜈蚣河

僅爾港減河以至北運而達楊村至其測法係依總技師之規定沿綫每一千英尺左右作旁綫各長二千英尺又基綫每一百尺求一水平點橫綫每五百尺求一水平點並測其地形

北運方面北向至馬頭鎮南至河西務一段測量範圍除兩堤中間之地形外堤外地平亦在勘测之列其有兩堤相距在四千尺以上者所有旁綫亦均經伸過堤外

青龍灣減河自近土門樓處起至入七里海止共長四十二英里蓋爲宣洩北運河之盛漲而設者也（參看第五圖）大白莊以上河流甚直兩堤之距約九百尺（參看第八九圖）堤頂均高出地平五英尺至十英尺不等河身約皆行淤塞兩岸之堤係沙土築成大水一至甚易潰決去年水漲決口數處最長者在中營迤下二里處長約六百尺云

青龍灣下游之地以決口及箭桿河汎濫之故浸成澤國者幾普遍焉

大白莊至潘兒莊約三十里夾河堤外均建有套堤惟北岸自距河頭至潘莊近處則僅有外堤而無夾河堤青龍灣減河至俵口（即七里海中）分爲二支（一）東引河（二）罾口河 東引河初爲青龍灣減河入海要道嗣因潘兒莊一帶村莊以每日潮水上汎有損禾稼遂於樂善莊築壩以遏潮流就防潮而論立意固善然其弊乃至橫阻河流致使河身淤塞水漫決口失宣洩之本意矣

罾口河上接小橫河（即篋兒港減河下游）中經七里海下入蘆運河爲天津至蘆台通航要道自東

引河堵塞後青龍灣河遂由此而入蘄運河達於海蘄運河下游又名北塘河曲折頗多

如欲用青龍灣減河洩北運河之盛漲則東引河必須通其堵塞而大加疏濬蓋蘄運一河未能容受此盛漲之流量也今依上次測量結果所得水平臚列如下

青龍灣河底高度當

一英里處	二二〇英尺
五英里	一九〇英尺
十英里	一六〇英尺
十五英里	一七三英尺
二十英里	一一三英尺
二十五英里	一〇五英尺
三十英里	七二英尺
三十五英里	四〇英尺
四十英里	五〇英尺
四十二英里	一〇英尺

營口河河底

施測時河水結冰得水面平度如下

三十五號斷（閘口靠下）冰面 = 24. 31 英尺

二千一百二十號斷 = 7. 76 英尺

四十里冰面之總 = 16. 55 英尺 河水坡度爲一與一萬三千之比

查北運河共有減河二道一即青龍灣減河一爲筐兒港減河筐兒港河頭在楊村北四英里處其尾閘亦分爲二一支入金鐘河一支入七里海滙入醫口河筐兒港引河所測者共長十五英里兩岸有堤約距二千尺河勢東南行八英里又折而向東者七里此河全行淤平河底已成耕地名實不符矣此河中游劉慶莊處東堤外有河東流名蜈蚣河東流至潘兒莊止其道甚直南岸靠河有堤高僅五尺當測量時河水乾竭深者只一尺四寸寬約一百尺兩岸地勢平坦無坡度之可言自筐兒港河頭至潘兒莊共長約二十七英里現在筐兒港減河床淤塞已失其宣洩之能力若將北運之水引入該河則左近各區必遭水患蓋其上游地勢尙微有傾斜中游以下乃極平坦不能引水就下也不寧惟是目前北運之水皆入箭桿河筐兒港固屬無用即使牛牧屯新河實行開關後則北運之水復歸故道亦以利用青龍灣減河洩漲較爲便利其故如下

(一) 青龍灣減河河流最直易於入海

(二) 疏濬之工費較省

(三) 若用經過七里海之叉綫爲永定河新尾閘則青龍灣亦可於俵口與之相滙

子牙河

查河工討論會審查會原議關於子牙河改道問題應行測量之地係在獻縣滏陽滹沱兩河交會處東至興隆鎮經過南運河復沿捷地減河東至祁口海岸全綫約長一百四十公里測區面積約寬五公里至十公里此次第三隊所測則有南北兩道北道測量之目的係擬在白洋橋附近引子牙東行至青縣過南運河東入於海南道則按照審查會原擬之範圍施測以資比較至兩道之孰爲優劣則仍須俟各河流量速度測有端倪始能判定耳

第三隊測量以青縣南運河東岸之李家鎮爲起點由李家鎮沿南運河上至窰子口下至二十里屯測綫各長約五英里測綫左右各寬約二千英尺沿綫每千尺測有旁綫每三千尺測有河身橫斷面李家鎮之北河流極形紆曲其南則否河面寬度當施測之時約有二百五十尺水面坡度約爲三英尺與十英里之比河身深度約十八英尺最深者一處在李家鎮迤南約三十六英尺河堤距離約七百英尺南運堤埝之現狀比較其他各河似稍欠完整推原其故或由當時事未能十分注意所有潰決多由居民零星補綴而鄉民避易就難往往於堤外另築新堤棄已決者於不顧河道既紆河灣衝刷力隨之增烈浸假新堤復決則復築新堤於決口之外積久遂成令狀矣

由青縣南運河接連白洋橋北子牙河之測綫爲B綫長約八英里測法同前此綫所經爲兩河距離最

近之路且只須在空城地方過黑龍港一次蓋黑龍港分中支東支西支至此始合流也

茲將以上各測綫所得兩河高低比較表列如左

	測勘時之水平綫	最高水平綫	河底高度	堤外地平
南運河	三三、八八	三六、五五	一八、一四	三三、七一
黑龍港	二二、八四	三一、一四	二二、一四	二二、七一
子牙河	二七、八九	三六、七一	一一、八九	二二、七一

據此則南運河通常水平較子牙河高至五尺九寸五分而南運河底亦較高五尺二寸五分此實將來計劃子牙改道問題所亟當研究者

由白洋橋東北 B 綫終點起沿子牙河下行測綫共長約五英里是為 C 綫由 B 綫終點溯子牙河上行至獻縣滏陽滹沱會流處測綫長約五十一英里是為 D 綫由 D 綫終點沿滏陽滹沱兩河測綫各長二英里為 E F 兩綫測法均同前茲將測勘所得獻縣及白洋橋附近子牙河高低比較表列如左

	測勘時水平綫	河底高度
白洋橋北	二八、三九	一一、三九
獻縣	四一、二七	三〇、二七

兩處距離爲二十七萬英尺水平綫差度爲十二尺八寸八分河底差度爲十六尺八寸八分是故水面坡度爲一與二萬一千之比河底坡度爲一與一萬六千之比當測勘之際全河河面寬度平均爲二百尺若在汎濫之時堤內河面每寬數百尺至數千尺不等通常河深約十四尺至二十尺汛期約深至二十七尺至三十五尺不等每年除冰凍時期外天津臧家橋間逐日皆有小輪航業兩岸堤防皆以素土膠土築成堤頂寬度八尺至二丈兩旁坡度僅一與一之比堤頂高度較之最高水平綫約高一尺之譜按子牙河河道以及河身橫斷面皆經詳細勘測該河流量已不難由此推算惟此次所有最高水平綫皆係訪自土人究難憑信仍宜以沿河所設各測站實地觀測者爲準蓋治河計劃必將流量之多寡並河水漲落情形及其時期之久暫詳加研究始有把握然則不惟流量測站爲當務之急域內重要地點之雨量測站尤宜及時設立而不容稍緩已

子牙河主要支流爲滹沱與滏陽兩河滹沱河發源於山西繁峙縣西北之泰戲山中九百里入直隸境又八十里經平山縣北入直隸平原又八百里至臧家橋西南與滏陽會滏陽河發源於直隸磁州迤西諸山經邯鄲縣南境入肥鄉北境復經曲周縣東南雞澤縣平山縣之東鉅鹿縣之西入北泊復由北泊東北流一百五十里與滹沱河會查滹沱河道遷徙無常頻年爲患田疇廬舍被淹沒者不知凡幾子牙河實蒙其害建議者多由臧家橋開掘減河引滹沱之水由興隆鎮入捷地減河出祁口入海爲言南

道測量即本此議

此項測量係遵照詹技師長三英里測量辦法施測爲日綫基綫左右各寬八千尺沿綫每八千尺皆測有旁綫（詳詹技師訓示）由滏陽漳沱交會處起點東至興隆鎮測綫長共四十二英里所經盡皆麥地其他種植則有梨棗諸品由起點循綫東行十英里過黑龍港十五英里過白龍港三十二英里過漳沱故道三十四英里過老清河是爲滄獻兩縣分界處此外尙有乾河數道日久壅塞河名已無從訪問矣所過村市則有滹鎮高川諸鎮焉

子牙河以東地勢皆東傾至老清河止過老清河地勢復逐漸增高以至南運西岸惟中間高低差距最多之數不過十二英尺耳至各河底之高低比較則如左表

子牙河（獻縣附近） 三〇·三

黑龍港 四一·五

滹沱舊道 二五·七

南運河（興隆鎮） 二二·三

據此則研究子牙河開闢尾閘計劃中之宜最先解決者實爲宣洩南運子牙間黑龍港流域諸水問題目前黑龍港各支皆在空城地方會流復下行至天津附近入子牙稽之往史滹沱河舊道係經過黑龍

港流域上游東北行至青縣迤南入南運河嗣後南運河水增高滹沱不能暢行以致青縣西部往往受害當局因將該道堵塞而子牙始爲滹沱唯一之尾閘此又研究宣洩黑龍港問題所當注意者也

測綫既至興隆鎮因選擇新減河通過南運之地點運河上下游皆施行細部測量測綫共長八英里在此八英里中河道極爲屈曲自上端起河流始則東北二英里後復折而東又二英里轉折而北當時河面均寬約二百尺堤埝相距自一千尺至二千尺不等堤頂高出地平約七八尺堤頂寬度十尺至二十尺

由興隆鎮捷地減河頭起至祁口入海處測綫共長約五十一里河流方向始則東北至孫正莊（距興隆鎮三十二英里有半）復折向東達海基綫皆循堤而行距興隆鎮四十五英里之處爲堤之盡頭有支流自西北來會捷地減河本人工鑿成用以宣洩南運之溢流者至此始合浮河經祈口入海耳

捷地減河兩岸堤防距離約三百尺高出地平八尺至十尺惟下游堤頂堤坡皆經土人耕種積久堤之外坡多被剗平甚至堤身有直立地面者每值盛漲輒有潰決之患沿綫每八千尺測有橫斷面所得捷地減河水面及河底坡度畧如左表

水 平 綫 河 底 高 度

興隆鎮 二四·三〇 一三三·三〇

浮河岔口上 三〇六

二九六

河身斷面及河底坡度既經測量則河流速渡可用岡居勒及喀特氏公式推算流速既得流量更不難知於是而將子牙河應行宣洩之水量與此河之容量兩相比較則捷地減河之是否足敷宣洩之用可立判矣

青縣祁口間之測綫自孫正莊捷地減河折向東流處起西北行至青縣止與青縣白洋橋綫相銜接測法同前全綫計長二十四英里有奇中間過張娘娘河該河久已淤塞河身堤岸均經鄉民犁種此外則田疇溝洫之外殆無足紀者沿綫地勢自運河迤東皆向下傾斜其各處高低比較如左表

青縣地平

二八〇

孫正莊地平

一五〇

祁口地平

一〇〇

據此若依此綫開掘減河宣洩南運當然適用無疑惟白洋橋青縣間尾閘是否可用尙待研究耳
現在所測子牙尾閘共爲二道

一由獻縣經興隆鎮取道捷地減河至祁口入海計長九十三英里

二由白洋橋經青縣入浮河至祁口入海計長五十二英里

如南綫不敷宣洩滹沱盛漲北綫尙可爲宣洩黑龍港流域諸水之用且二者均於祁口一途入海更不妨並存至於運河水平綫雖較子牙爲高若於運河設置活動堰閘操縱水量則仍能收效也

精細水準測量

第四隊在蘆溝橋郭家務間所有各種測量業於永定河報告中畧述查該隊係以海河工程局蘆溝橋之水準點爲起點以河道測勘處郭家務之水準點爲終點而第一隊亦即以此處爲起點

前段測量既竣該隊復回津由紅橋上之海河工程局水準點起測至興隆鎮第三隊起點止

查第三隊係在青縣根據河道測勘處之高度施測第四隊係在紅橋根據海河工程局之高度施測其結果在青縣水準點上兩隊所得之高度各如左

青縣水準點 根據河道測勘處所得之高度 三三一、四六三

根據海河工程局所得之高度 三六一、一七三

據此則根據河道測勘處所得之高度實較根據海河工程局用大沽海平綫所得之高度低有三尺七寸一分之多此項差點嗣後復經第三隊證實蓋第三隊初用河道測勘處之高度在青縣起點比至那口發現該測勘處之高度零點乃在平均低潮綫之上三尺有奇也（按大沽海平綫零點係以平均低潮綫爲準）

該隊繼由青縣沿南運河上測以與第三隊由青縣經白洋橋藏家橋以至興隆鎮所測之水準點相接查第三隊水準測綫共長一百英里兩隊相接其結果之差數僅如左方

第三隊所得之高度

三六·五二六

第四隊所得之高度

三六·七九五

差數

〇·二六九

按英美水準測量通例每英里兩次差數至多以一尺之百分之四爲限而差限則與里數之平方根爲正比因之每百英里之差限爲一尺之十分之四而此次兩隊相較一百英里中相差僅一尺之百分之二六九可稱精確矣

該隊旋復回津由大沽海平綫水準點起上測至紅橋水準點止因時間短促未及覆測而所得結果則與海河工程局原用之高度相差極微因之測量局所有水準測量高度皆即以紅橋水準點海河工程局原用之高度爲準

第一隊水平起點在郭家務第二隊起點在牛牧屯兩隊皆用河道測勘處之水準點着手惟兩隊採用之各該水準點高度不無訛舛因之兩隊至楊村同一水準點上所得高度未能符合嗣後兩隊測綫至龍鳳橋紅橋又各於同一水準點上互相比較其結果如下

	海河局高度	第一隊所得高度	第二隊所得高度	兩隊差數
在楊村	三七、五〇〇	三四、七九六	三七、〇八六	二、二九〇
在龍鳳橋	無	二七、八三七	三〇、一四四	二、三〇四
在紅橋	一六、六三〇	一四、七二九	一七、〇九六	二、三六七

據此則第一二兩隊在楊村至紅橋間所有水準點高度之差數均屬相等足徵兩隊成績皆有可觀而兩隊在楊村水準點上之未能相符者實由於起點處採用之高度未盡足恃而然更毫無疑義矣

茲將各該河測量大致情形及測量局開支一切經費分別臚陳於左

各河成績總算

期	間	英里總數	備	考
第一隊	一月十七日至五月十日	二五二、九五	四千寬測綫 一萬六千尺寬測綫 其他測綫	五四、五〇英里 八三、二六英里 一一五、一九英里
第二隊	一月十六日至四月十三日	二四二、〇三	四千尺寬測綫 一萬六千尺寬測綫 大清河測綫 其他測綫	一四八、七一英里 四八、三四英里 三五、〇六英里 九、九二英里
第三隊	一月十六日至五月二日	二三七、二七	四千尺寬測綫 一萬六千尺寬測綫 其他測綫	八三、〇二英里 一三三、〇四英里 一七、二一英里
第四隊	一月十六日至五月十三日	一八二、一六	永定河精細水準測量 運河精細水準測量 大沽口至紅橋水準測量	五三、八八英里 八五、九四英里 四二、三四英里

右列測量期間皆從各隊離津之日計算

測量經費

查審查會報告測量永定北運兩河預算書內開永定河應測地段共一百公里北運河共二百一十公里測量費共需六萬元行政費不在其內測量子牙河預算書內開應測地段共長一百四十公里共需費三萬三千九百元總計除行政費不計外共需九萬三千九百元茲將此次測量局測量永定北運子牙三河開支各項開列於左

一 測量經費

測量隊開辦費

購置儀器等項

七千四百三十五元五角三分

技師長及副技師薪費

九千五百九十元

第一隊測師測伏薪費及雜費等項

共四個月

二萬一千五百零三元七角七分

第二隊共四個月

一萬九千九百五十八元七角八分

第三隊四個月

一萬九千六百二十四元七角五分

第四隊四個月

四千一百三十三元二角九分

共支測量經費八萬二千二百四十一元一角二分

二 行政經費

測量局開辦經費

一千六百三十四元六角九分

測量局員司薪金雜費等項共六個月

一萬五千四百二十四元一角五分

共支行政經費一萬七千零五十八元八角四分

右除行政費未列入預算外共支測量經費八萬二千二百四十一元一角二分比較預算九萬三千九百元計節省一萬一千六百五十八元八角八分而測量成績則已測各地段較審查會所指定者超過一倍以上

副技師長葉瑞國

中華民國七年八月八日

附錄

各隊所有平面剖面各圖詳表

平面圖

第一隊

地點	測綫	張數	比例尺
郭家務至雙口	M	十一	四千八百分之一
雙口至北塘	M	二	二萬四千分之一
北塘至漢沽	H	一	全
龍鳳橋至紅橋	G	四	四千八百分之一
郭家務至漢溝	I	二	二萬四千分之一

第二隊

第三隊

青縣至白洋橋	南運河青縣附近	地 點	漢溝至蘆台	潘兒莊至楊村	青龍灣減河至潘兒莊	牛牧屯至河西務	地 點
B	A	測 綫	X	N	M	A C H	測 綫
三	三	張 數	三	十	十 一	六	張 數
全	四千八百分之一	比 例 尺	二萬四千分之一	全	全	四千八百分之一	比 例 尺

第四隊

孫正莊至青縣	獻縣至祁口	白洋橋至獻縣	白洋橋至中趙扶
P	H	D	C
二	五	十四	一
全	二萬四千分之一	全	全

第一隊

剖面圖

地 點	蘆溝橋至郭家務	地 點	
測 綫		測 綫	
卷 數	一	張 數	
	六萬分之一	比 例 尺	

積水區域	永定河新道	永定河故道	南灣堤	永定河北月堤	北塘至蘆台	龍鳳橋至紅橋	郭家務至漢溝	郭家務至北塘
E	D	C	B	A	H	G	I	M
一 卷	一 卷	一 卷	一 卷	一 卷	一 卷	一 卷	一 卷	一 卷

第二隊

北遙堤	F	一卷	
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漢溝至蘆台	晉口河	蜈蚣河 至楊村	青龍灣減河至潘兒莊	箭桿河至北運河	地 點
X	Y D	N	M	C.H	測 綫
一 卷	二 卷	一 卷	一 卷	一 卷	卷 數

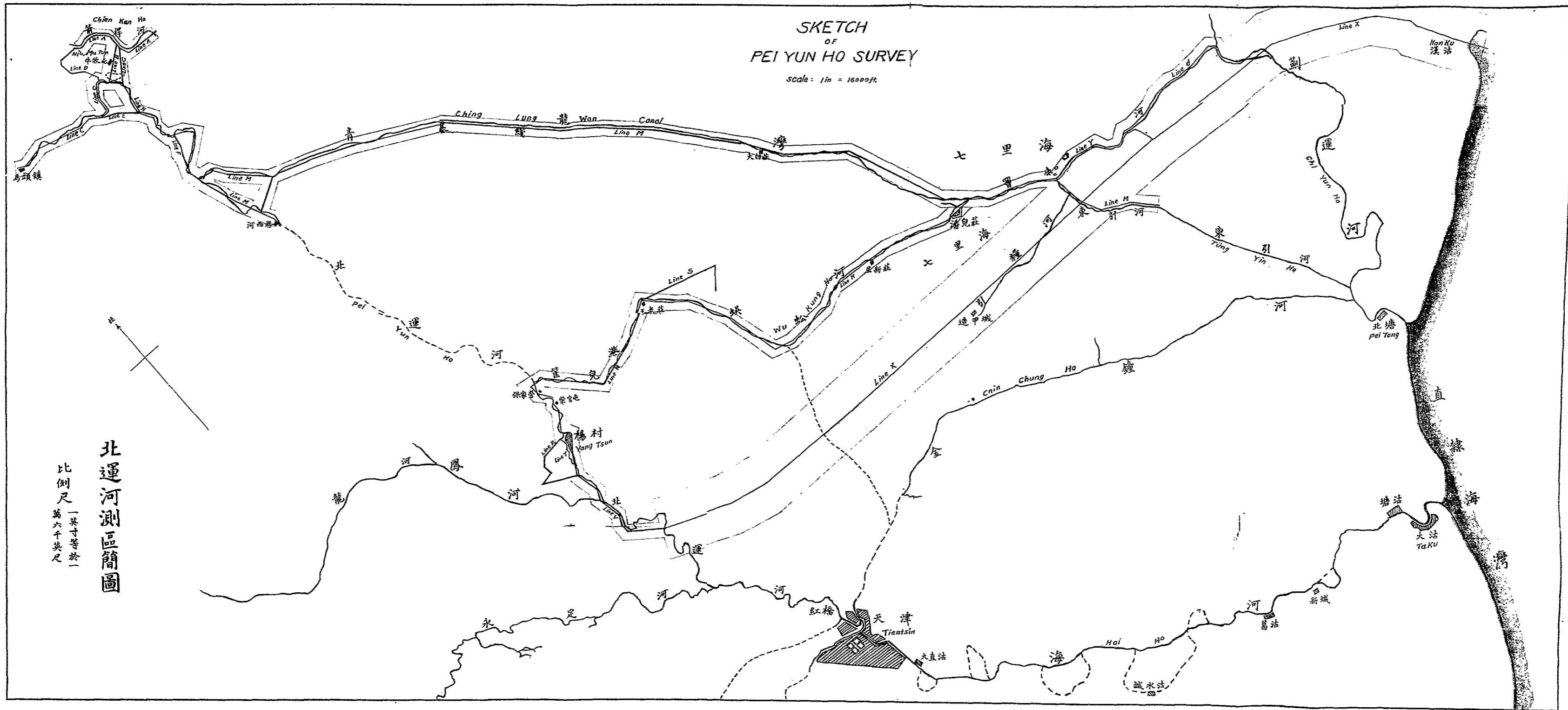
第三隊

第四隊

地點	測綫	卷數	
南運河 青縣附近	A-A	一卷	
青縣至白洋橋	B	一卷	
白洋橋至獻縣	C.D E.F	一卷	
獻縣至祁口	H	一卷	
孫正莊至青縣	P.P.	二卷	
地點	測綫	卷數	
永定河上游橫斷面圖		一卷	
蘆溝橋至 北塘 蘆台		一卷	

SKETCH
OF
PEI YUN HO SURVEY

scale: 1 in = 16000 ft.



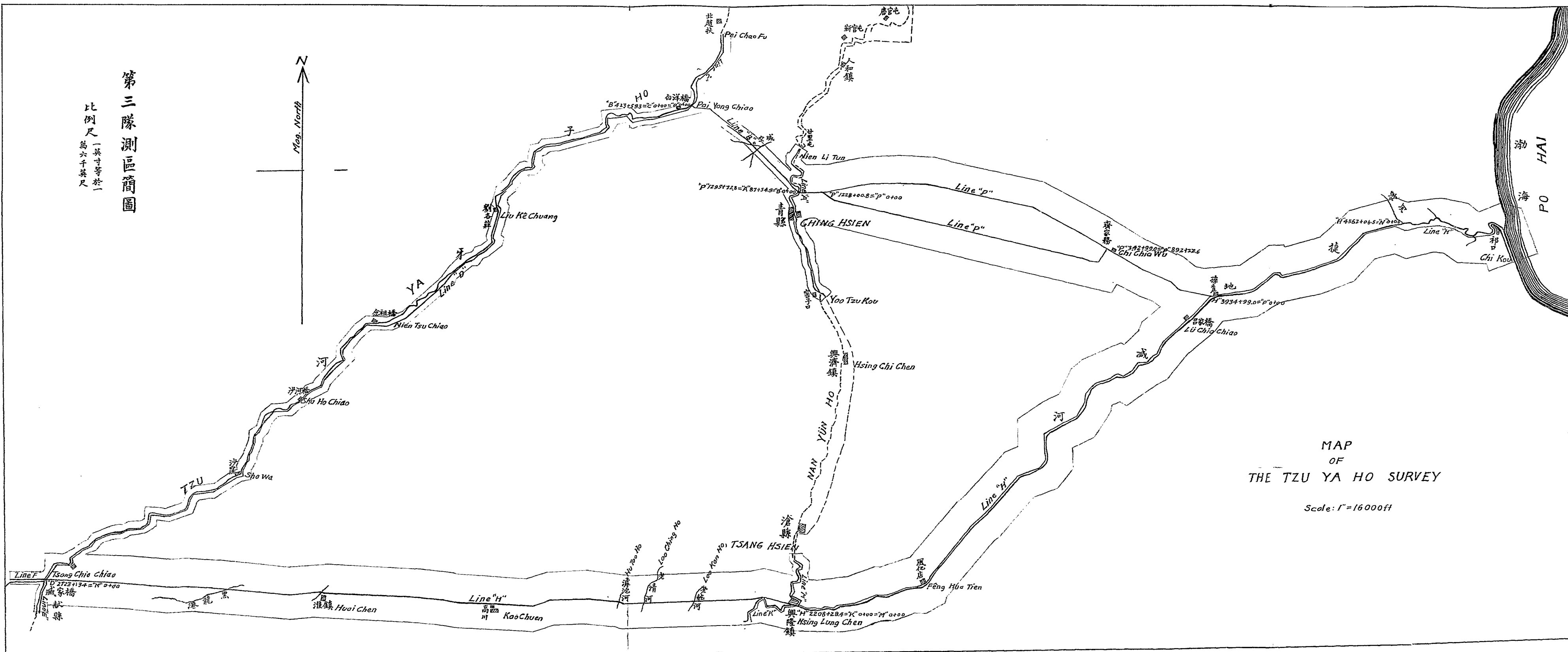
北運河測區簡圖

比例尺 一英寸等於一萬六千英尺

第三隊測區簡圖

比例尺 一英寸等於一萬六千英尺

Mag. North

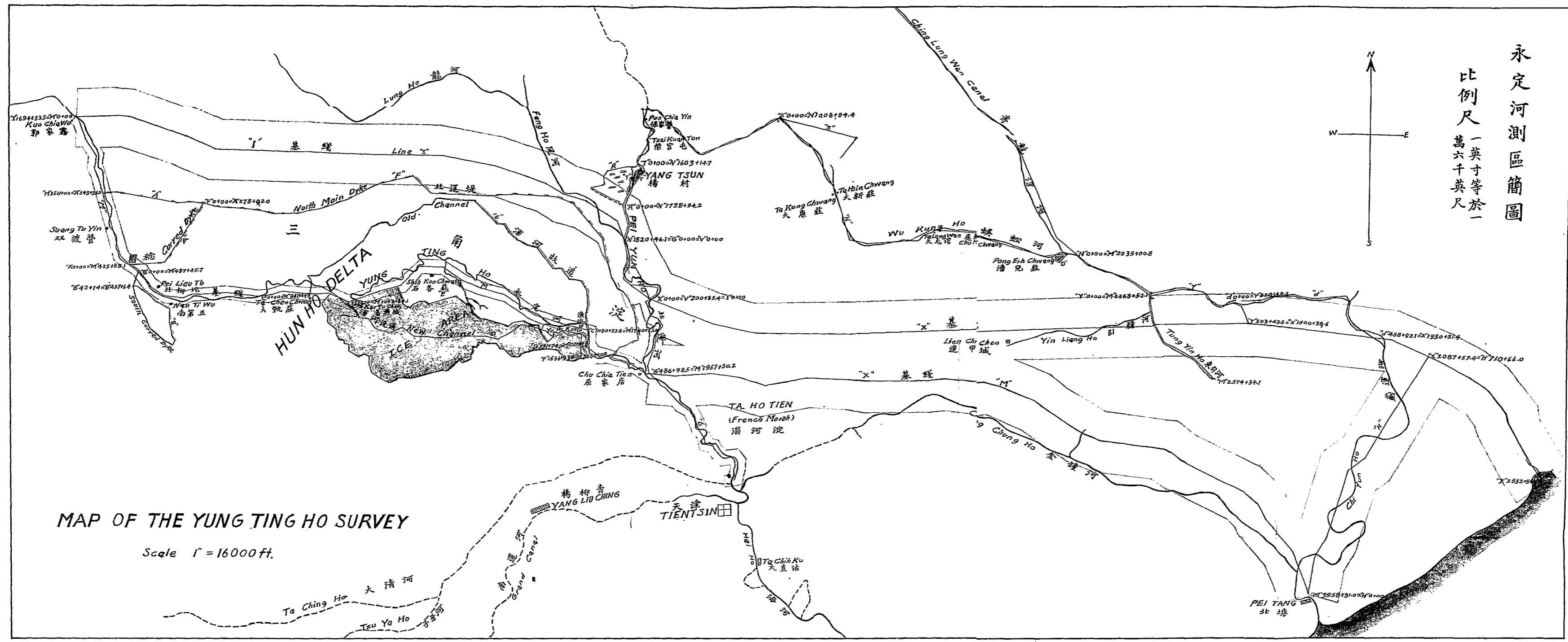
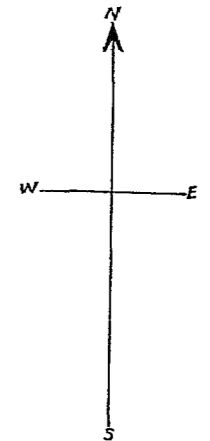


MAP OF THE TZU YA HO SURVEY

Scale: 1" = 16000ft

永定河測區簡圖

比例尺 一英寸等於一萬六千英尺



MAP OF THE YUNG TING HO SURVEY

Scale 1" = 16000 ft.

COST OF THESE SURVEYS.

According to the Report of the Sub-committee, the cost for surveying 210 kilometers in the Pei Yun Ho, and 100 kilometers in the Yung Ting Ho was estimated at \$ 60,000., administration expenses not included; 100 kilometers on the Tzu Ya Ho at \$ 33,900., thus making a total of \$ 93,900. excluding administration expenses. The following shows the amount of money expended by each party and the administration.

Field Parties organization expenses i. e. cost of instruments, outfits &c.	\$ 7,430.53
Salaries of Chief Engineer and of Assistant Chief Engineer.	9,590.00
Salaries of engineers and staff, wages of surveying coolies and running expenses for 4 months	
Party 1	21,503.77
" " " " " " " " Party 2	19,958.78
" " " " " " " " Party 3	19,624.75
" " " " " " " " Party 4	4,133.29
Total Survey Expenses.....	\$ 82,241.12
Administration organization expenses i. e. cost of office outfits &c.	\$ 1,634.69
Salaries of office staff and running expenses for six months.	15,424.15
Total administration expenses.....	\$ 17,058.84
Estimated cost of these surveys	\$ 93,900.00
Actual " " " " " " " "	82,241.12
Balance on hand	\$ 11,658.88

This balance shows a saving of \$ 11,000.00 on these surveys.

Though there is a saving on the cost, the surveys, on the other hand, were, as can be seen from the table more than double what was originally called for.

LIST OF PLANS AND PROFILES

Party	Line	Scale	No. of sheets	REMARKS
1	M	1" to 400 ft.	11	Yung Ting Ho from Kuo Chia Wu to Pei Yun Ho.
	G	1" to 400 ft.	4	Pei Yun Ho from Lung Feng Chiao to Hsi Ku.
	M	1" to 2000 ft.	2	From Pei Yun Ho to Peitang
	H	1" to 2000 ft.	1	From Peitang to Hankou.
	I	1" to 2000 ft.	2	From Kuo Chia Wu to Hankou.
	ABCDEF	—	—	Traverse lines.
2	A	1" to 400 ft.	1	Ta Sha Wu (Niu Mu Tun cutting)
	C	"	2	Pei Yun Ho Ma Tao Chen to Yang Chia Wu.
	H	"	3	Pei Yun Ho from Niu Mu Tun to Ho Hsi Wu.
	M	"	11	The whole Ching Lung Wan Canal.
	N	"	10	Wu Kung Ho from Pan Erh Chwang to Yangtsun.
	X	1" to 2000 ft.	3	From Hankou to Hankou.
3	A	1" to 400 ft.	3	Grand Canal near Ching Hsien.
	B	"	3	From Ching Hsien to Pei Yang Chiao.
	C	"	1	Tzu Ya Ho from Pai Yang Chiao downstream
	D	"	14	Tzu Ya Ho from Pai Yang Chiao to Hsien Hsien.
	H	1" to 2000 ft.	5	From Hsien Hsien to Chi Kow via Hsin Lung Chen.
	P	"	2	From Sun Chia Chwang to Ching Hsien.
4	B	1" to 5000 ft.	1	Yung Ting Ho from Liu Kuo Chiao to Kuo Chia Wu.

Each of the above lines has a profile in the following scale.

Vertical scale 1" to 20 ft.

Horizontal " 1" to 400 ft.

Elevation of B. M. No. 3149 near Hsing Lung Cheng	= 36.526
" " " " " " checked by 4th Party	= 36.795
	Difference = .269

This proves the accuracy of levelling work done by the party. In the geological survey of the U. S. A. the permissible error in levelling is 0.04 ft. $\sqrt{\text{miles}}$.

$$\begin{aligned}
 \text{For 100 miles the Permissible error} &= .04\sqrt{100}. \\
 &= .04 \times 10 \\
 &= .4 \text{ of a foot.}
 \end{aligned}$$

The accurate levelling done by the 1st and 2nd party may also be seen from the following 3 common B. Ms. Each party started with different datum but the difference show a very small variation for the distance of about 19 miles.

B. M. at	Yangtsun	LungFeng Chiao	Red Bridge
Elevation of 1st party before correction	34.796	27.837	14.729
Elevation of 2nd party before correction	37.086	30.144	17.096
Difference	2.090	2.304	2.369

The above difference of .077 of a feet for a distance of about 19 miles shows good levelling done by these parties.

THE PRECISE LEVELLING PARTY.

The first part of the work done by this party has already been described in the Yung Ting Ho Survey. They started with the Bench Mark at Lu Kou Chiao established by the Hai Ho Conservancy, the value of which is given in the Hai Ho Conservancy Topographical map and finished on the a Bench Mark of the River Survey Bureau of the Chihli Province which the 1st Party took for their work at Kuo Chia Wu.

The next work after this was to check the Bench Marks used by the 3rd Party at Ching Hsien. This Bench Mark also belonged to the River Survey Bureau. The party started from Tientsin and adopted the Hai Ho B. M. at the Red Bridge as the basis they first checked the B. M. at Ching Hsien.

Elevation of B. M. of River Survey Bureau	=	32.463
" " " " checked by 4th Party	=	<u>36.173</u>
Difference	=	3.710

This shows that the value of B. M. given by the River Survey Bureau was 3.710 feet higher than the Taku Datum.

The same conclusion has also been arrived at by the 3rd Party when they carried the Elevation of the River Survey Bureau's B. M. at Ching Hsien to Chikow they found that the zero is same 3 feet above mean low water.

From Ching Hsien the levelling was carried on along the Canal to Hsing Lung Chen in order to check the Bench Marks of the 3rd Party, who had done about 100 miles of levelling, and it was found that

From the point at mile $32\frac{1}{2}$ where the course of the Chieh Ti Canal deviated from the north east to the east, a line was run direct to the north west to join the starting point at Ching Hsien, this connects the line from Pai Yang Chiao in the Tzu Ya Ho with Chi Kou via Ching Hsien and Sun Cheng Chuang (孫正莊). This was surveyed in the same manner as the H. line. The country passed by this line was practically featureless, mostly flat cultivated lands with many drains except that at about half way the line crossed the Chang Niang Niang Canal. This canal has been so silted up that its bed and banks are all cultivated. The total distance of this line is a little more than 24 miles and the ground has a gentle slope from the Grand Canal to the east.

The ground level at Ching Hsien	Mile 0=28.00
" " " " Sun Cheng Chuang	" 24=15.00
" " " " Chi Kou	" 44=10.00

It is quite possible to make an overflow canal from Ching Hsien to the sea on this route. But whether it is feasible to have the new outlet from Pai Yang Chiao to Chi Kou via Ching Hsien, is not a question to be settled off hand.

Thus the two possible outlets for the Tzu Ya Ho are given below.

1. From Hsien Hsien to Chi Kou via Hsing Lung Chen and Chieh Ti Canal. Total distance 93 miles.
2. From Pai Yang Chiao to Chi Kou via Ching Hsien and Fu Ho. Total distance 52 miles.

If the 1st outlet were found not capable to drain off all flood waters of the Pu Tao Ho and relieve the country from inundation, the 2nd outlet may be found useful in helping to drain the waters from the Hei Lung Kang basin. i.e. there will be no objection to having two channels as both outlets will meet and form one before reaching the sea. The difficulties in the difference of water level in Tzu Ya Ho and Grand Canal may be overcome by building regulating works which will control the flood waters in these rivers.

water rose higher than usual, the dykes having no support from the slopes cannot stand the thrust of the water so well as the dykes with slopes so many dyke breaks and flooding are common occurrence.

The cross-section of the canal has been taken at interval of 8000 feet by soundings, from which the gradient of its bed may be obtained. For instance.

Station 2240.	Station 4480.
W. L. = 24.30	W. L. = 3.06
Bed Elevation = 23.30	Bed Elevation = 2.96

From the sectional area of the channel of this canal and the gradient of its bed, we may find out whether its carrying capacity is sufficient for the discharge of the waters of Tzu Ya Ho when the outlet is made. If no actual observation of velocity has been taken we may find it by using the Ganguillet and Kutters' formula :

$$V = c \sqrt{R \cdot I}$$

$$c = \frac{23 + \frac{1}{n} + \frac{0.00155}{I}}{1 + \left\{ 23 + \frac{0.00155}{I} \right\} \frac{n}{\sqrt{R}}}$$

where V.=the velocity in feet or meter per second.

R.=the Hydraulic radius = $\frac{\text{sectional area of the river bed}}{\text{wetted perimeter.}}$

I.=the inclination of the water level.

n.=a coefficient depending upon the roughness of the river bed.

But the factor n must be first determined for this computation.

Having obtained the velocity of flow in this canal we may be able to calculate the discharge. When the volume of water to be drained from the Tzu Ya Ho is known, we can easily see whether this canal is serviceable or not.

After the line has reached Hsing Lung Chen, the head of the Chieh Ti Canal, the Grand Canal was surveyed in detail up and down for about four miles each way for the location of a suitable junction in case a new outlet for the 'Tzu Ya Ho is contemplated. In this 8 miles of survey on the Grand Canal, it shows that the canal is very crooked. Starting from the upstream end it runs north east for the first two miles and then to the east for another two miles and again has zigzag course to the north. The wetted channel at the time of survey was very uniform in width about 200 feet all the way, but the width of the dykes varied from one to two thousand feet apart, and their height was about 7 or 8 feet above the ground level and 10 to 12 feet wide on the top.

From Hsing Lung Chen, the head of Chieh Ti canal to Chi Kou its outlet to the sea, the total distance was found to be about 51 miles, and the general direction was a straight course to the north east from Hsing Lung Chen to Sun Cheng Chuang at mile 32½ and from the latter to the sea its bearing was to the east.

The centre line was run along the dyke all the way until mile 45 where the dykes terminated. At mile 45 the canal was joined by the Fu Ho. That this canal was purely an overflow canal for the Grand Canal may be proved from the dykes which were built as far as the Fu Ho and no more, they were very regular and also that the name on its lower course was locally called the Fu Ho and not the Chieh Ti Canal.

The dykes were about 300 feet apart, and the average height above the ground level was from 8 to 10 feet. But the dykes in the lower course were greatly ruined by the natives who tilled the soil on their tops and gradually extended their cultivation to the slopes especially on the outside, bank which were levelled down step by step until they got even with the ground, thus leaving the dykes without any slope and the consequence was that in time of flood when the

It passed through cultivated land of wheat fields with orchards of pears, peaches and dates, here and there, and crossed the old Hei Lung Kang at mile 10, the Pei Lung Kang at mile 15, the old course of Pu Tao Ho at mile 32, the old Chien Ching Ho at mile 34 which is the boundary line of Hsien Hsien and Tsang Hsien, and several other dry old channels. The most important villages passed by besides Hsien Hsien and Hsing Lung Chen are Huai Chen (淮鎮) at mile 15 and Kao Chuang (高川) at mile 25.

The general configuration of the country traverse by this line has a gentle fall from west to the east, until to the east bank of the old Chien Ching Ho (mile 34) whence the ground rises again until the Grand Canal is reached.

The difference in elevation between the highest and lowest of actual ground level is about 12 feet.

Elevation of the bed Tzu Ya Ho at Hsien Hsien.....	20.3
" " " " Hei Lung Kang bed.....	41.5
" " " " Old Pu Tao Ho.....	25.7
" " " " Grand Canal at Hsing Lung Chen	2.33

This shows that bed of the Tzu Ya Ho is below that of any other river and it will be seen that one of the deciding factors in the design of a new outlet for the Tzu Ya Ho is the provision for the drainage of the Hei Lung Kang Basin, the country bounded by the Grand Canal on the east and the Tzu Ya Ho on the west, with all its tributaries join together at Kung Chen on line B. in the lower course (see map). According to the Chinese history "the Pu Tao Ho once ran along the upper course of the Hei Lung Kang basin from the south west to the north east and emptied itself into the Grand Canal south of Ching Hsien. But as the water level of the Grand Canal was higher than that of the Pu Tao Ho, the whole country west of Ching Hsien was submerged under water all the time, its outlet was obliged to be filled up. Since then the Tzu Ya Ho remains to be the only outlet for the Pu Tao Ho.

It is mostly due to this Pu Tao Ho that the survey for a new outlet had to be made. This river having no permanent bed in its lower basin causes inundation during freshets and renders homeless thousands of families and destroys as many acres of valuable crops. In order to relieve these poor sufferers from inundation which occurs nearly every year, some radical remedy has to be found. It was proposed to have an entirely new outlet made from Hsien Hsien, to Hsing Lung Chen (興隆鎮) on the Grand Canal, and hence, by making use of the Chieh Ti Canal, to be sea at Chi Kou.

The method adopted for this survey was according to the Chief Engineer's "Instruction for surveys three or more miles in width." That is a centre line was carefully run along an indicated route with the transit and accurately chained, the elevation of each station taken and Bench Marks established at suitable points. These B. Ms. were checked by the Check Level party. Topography was taken some 500 or 600 feet out on each side of the centre line, especially at the crossings of water courses showing the general direction of flow and the width of any defined channel, if any exists, and the location of any town or hamlet near the centre line. An offset line of eight thousand feet in length was run at right angles to the centre line on each side at 8000 feet interval, on which levels were taken every 50 feet. These lengths were not absolute requirements. Sometimes the lines may be extended in order to obtain some important features, or it may be shortened when there was nothing in particular, but a waste of time in levelling one the last thousand feet.

THE H. LINE

The indicated route was continued from the junction of the Tzu Ya Ho, Pu Tao Ho and Fu Yang Ho east ward up to the Grand Canal in a more or less straight course. The total distance of this line from Hsien Hsien to Hsing Lung Chen is 42 miles.

established at certain important points on the river. No system can be designed in an intelligent manner until the flood discharges are carefully studied, not only the amount of water that were carried down the river, but the manner in which it came, i. e. whether the flood came in a short duration or spread out in a length of time. This involves not only the river gauging stations established at important points of the river, but rain gauge stations should also be set at important points throughout the entire area, and having observations begin at once is by far the most important.

The two principal tributaries of the Tzu Ya Ho are

1. The Pu Tao Ho,
2. The Fu Yang Ho.

These two rivers meet, as stated before, at a point two miles west of Tsang Chia Chiao or Hsien Hsien.

Pu Tao Ho, the longest tributary of the Tzu Ya Ho, has its source originated from the Tai Hsi Shan (泰西山) north west of Fan Sze Hsien (繁峙縣) in the province of Shansi. After a winding course through the hilly regions for a distance of about 900 li, it reaches the Chihli Province. Then for another 80 li, it passes through north of Ping Shan Hsien (平山縣) thence it runs over a very long plain for about 800 li and meets the Fu Yang Ho at the above mentioned place.

The source of the Fu Yang Ho, the other tributary of the Tzu Ya Ho rises from the western hills of the Tse Chow (磁州) south west of Chihli, passing through south of Han Tan Hsien (邯鄲縣) and then north of Fei Hsiang Hsien (肥鄉縣) and south east of Chu Chou Hsien (曲周縣) again east of Chi Tse Hsien (鷄澤縣) and Ping Hsiang Hsien (平鄉縣) then west of Chu Lu Hsien (鉅鹿縣) where it flows into a large reservoir known as Pei Po (北泊) or Chu Lu (鉅鹿) and drains off from the north east and continues for about 150 li before it joins with the Pu Tao Ho.

Hsien, half a mile below the junction, is fifty one miles and the difference in elevation between these two places are shown below.

	W. L.	Elevation of River bed
At Station O	28.39	13.39
" " 2700.	41.27	30.97

For a distance of 270,000 feet the difference of W. L. being 12.88 and that of the river bed at the two points 16.88.

Therefore we have the hydraulic gradient of $\frac{18.88}{270000}$ or 1 : 21000,

and the slope of the river bed is $\frac{16.88}{270000}$ or 1 : 16000.

The width of the river bed at ordinary time i. e. the channel actual covered by water at the time of survey, was about 200 feet, all the way. But its major bed, i. e. the channel between the dyke as banks covered by water in flood season, vary from a few hundred feet to several thousand. The depth of water in the river varies from 14 to 20 feet at ordinary time and from 27 to 35 in flood season, and a steam launch service is run daily from Tientsin to Tsang Chia Chiao except when the river was frozen.

The dykes on both banks of the river were built with loam and clay. Their dimensions are from 8 to 20 feet in width across the top and the slope is about 1 : 1. The top of the dykes is about one foot above H. F. L. and in many places, and as a protection against flood, an outer dyke or even two were built at some distance from the channel dyke.

The channel of the Tzu Ya Ho from Pai Yang Chiao to Hsien Hsien has been surveyed in detail and cross sections of the river bed taken, and the velocity of flow could be calculated if necessary. Still the H. W. L. as given by the natives cannot be relied upon, but it should be taken by actual measurement from Gauging Stations

by piecemeal. The consequence is that, instead of repairing the broken part of the dyke, a new one was put round the old one, thus changing the original straight course to a curve and afterward the force of the current coming round a bend soon eroded the outer arm of the dyke and later cause it to break and another one was being built round it again, that is how the Grand Canal has so many bends.

The line B. connecting the Grand Canal and the Tzu Ya Ho started 2 miles north of Ching Hsien and terminated about a mile east of Pai Yang Chiao (see Key Map). The total distance of about eight miles is the shortest between the 2 rivers, and another advantage is that it has to cross the Hei Lung Kang only once at Kung Cheng, the junction of the three branches of the Hei Lung Kung Ho.

The method of survey is the same as before, except that no sounding was required on this line. Following are some of the data from the result of the survey.

	Grand Canal.	Hei Lung Kang.	Tzu Ya Ho
Water Level at the time of Survey.	33.88	22.84	27.89
H. F. L. as informed.	36.55	31.14	36.71
Elevation of river bed.	18.14	22.14	12.89
General Ground Level.	32.71	22.71	23.71

Thus it will be seen that the ordinary W. L. of the Grand Canal is higher than that of the Tzu Ya Ho by 5.95 feet and the Canal bed is also higher by 5.25 feet. This is one of the problem to be solved in the designing of the new outlet for the River.

At the end of line B. the survey was extended downstream along the Tzu Ya Ho, north east of Pai Yang Chiao, for 5 miles. This line is the "C" G line of Party 3, again the line was continued from the end of B. to the junction of Fu Tao Ho and Fu Yang Ho (line D). Its general direction was to follow the river upstream in a south westerly course up to the junction and then 2 miles along each of the rivers. The length of this line from Pai Yang Chiao to Hsien

THE TZU YA HO.

According to the programme recommended by the Subcommittee regarding the new outlet for the Tzu Ya Ho, it was proposed to survey a strip of country 5 to 10 kilometers wide from Hsien Hsien, the junction of Pu Tao Ho and Fu Yang Ho, to the sea at Chi-Kou via Hsien Lung Chen a distance of about 140 kilometers.

Two possible outlets for the Tzu Ya Ho were surveyed. Each has to carry the Grand Canal and the Tientsin-Pukow Railway which one will serve best can be known when the flood discharge of the river and other data are known.

The first one is to lead the waters of Tzu Ya Ho to the Grand Canal at Ching Hsien from Pai Yang Chiao, a distance of about eight miles, and then from Ching Hsien to the sea.

The second one is the route recommended by the Subcommittee, viz: from Hsien Hsien to Hsing Lung Chen on the Grand Canal and thence to the sea via the existing Chieh Ti Canal.

The first starting point of the third party was on the Grand Canal which was surveyed for about ten miles, 5 miles each way from Li Chia Chen or Ching Hsien. (青 縣)

This survey included a strip of country some two thousand feet wide on each side of the Main Line. which followed more or less the course of the Grand Canal, cross-sections being taken every thousand feet and sounding every three thousand feet interval.

The Grand Canal north of Li Chia Chen, due to its breaks and repairs, has many bends, but is comparatively straight on the south. The depth of the Canal given by soundings was about 18 feet, except at one place half mile south of Li Chia Chen where it was 36 feet. The average width between the dykes was about 700 feet, they did not seem to be so well taken care of by the authorities as some of the other rivers, Failure to maintain in good condition hastened the wear and tear on the dykes and if repairs were to be done they were left to the natives, who can only be done

3. If the "X" line through Chi Li Hai for the outlet of the river Yung Ting, is made, the Pei Yun Ho water can be drained to the same outlet near the village of Piao Kou (俵 口).

is 27 miles. For the first 14 miles the Kuang Erh Kang Canal half has dykes on both sides about 2000 feet apart on the average, It runs a south eastern course until it reached mile 8, whence the course is inclined to the south for another 7 miles. This canal has been so silted up that the channel inside the dykes were all cultivated and very little trace of the canal could be seen now.

At mile 15 from Pei Yun Ho the canal is joined by the Wu Kung Ho. Its direction was a very straight course to the east and only the south bank has a dyke about 5 feet high, very close to the river bed. At the time of the survey very little water (or rather ice) was in it and the depth was about 1.4 ft. The average width is about 100 ft. The ground level of the adjoining country on this portion is also very flat, there is hardly any fall from the mile 15 to mile 27.

At far as the overflow is concerned the Kuang Erh Kang has lost its function now, as its bed has been so silted up and cultivated, that this canal could not drain much water from the Pei Yun Ho to the sea without causing inundation to the country through which it passed. From the head of the Kuang Erh Kang the ground level has a comparatively slight fall until half way down, when the ground is practically level all the way up to the end of the canal. In any case this overflow canal cannot be of much service, seeing the Pei Yun Ho waters does not come along its own course, should the Niu Mu Tun Cutting be made and the waters of Pei Yun Ho brought back again to its channel, the Ching Lung Wan may be used as an overflow canal for the following reasons:—

1. It is the most direct and straight course.
2. Its improvement to be done for effective draining of flood waters is comparatively less than the 2nd flood escape. The necessary work for its improvement is the repairing of dykes breaks, dredging, and the most important is the opening of the outlet from the end of the canal to the sea.

Ho is also called Pei Tang Ho, it has a very zig-zag course.

If the Ching Lung Wan is to be used as an overflow canal for the Pei Yun Ho, the outlet of Tung Yin Ho has to be greatly improved. As the Chih Yun Ho has not the capacity to cope with these additional waters from the Ching Lung Wan canal.

The following are elevations of the canal bed taken from the date of the last survey (Jan. - Feb. 1918).

Elevation of canal bed at mile	1 =	22.0
" " " " " "	5 =	19.0
" " " " " "	10 =	16.0
" " " " " "	15 =	17.3
" " " " " "	20 =	11.3
" " " " " "	25 =	10.5
" " " " " "	30 =	7.2
" " " " " "	35 =	4.0
" " " " " "	40 =	5.0
Bed of Tseng Kou Ho at mile	43 =	1.00

During the time of Survey all the river was frozen, the following give the water surface between the 2 ends of the canal.

At station 34 (Just below the weir) ice surface	=	24.31
" " 2120 " " "	=	7.76
Difference of ice level for 40 miles	=	16.55
Water level slope	$\frac{16.55}{208600} = \frac{1}{12600} =$	.00008

Assuming that the ice proze at the same the hydraulic gradient is given by the above equation.

Four mile north of Yang Tsun the Pei Yun Ho has another overflow canal to the sea. This canal has two outlets, one of which empties into the Chin Chung Ho and the second joins the Wu Kung Ho. It was the latter that has been surveyed. The first half of this survey was on the Kuang Erh Kang Canal and the second half the Wu Kung Ho. The total length of this canal from Yang Tsun to Pan Erh Chuang

above the ground level outside the dykes vary from 5 to 10 ft., nearly the whole canal bed were silted up and the dykes were built with loose sand and consequently they are very easily damaged by flood. During the flood of last year several breaks had occurred, the longest one about 600 ft. long was the Chung Ying (中營).

Half way down the canal the whole country outside the dykes are below the bottom of the Canal bed and were flooded not only from the waters coming through the breaks but also from the waters of Chien Kan Ho.

From Ta Pai Chuang to Pan Erh Chuang a distance of about 10 miles an outer curved dyke was put up in addition to the channel dykes which are still very close as before, except the north dyke between from mile 30 to mile 34 has only the outer dyke.

At Piao Kou Chuang (俵口莊) about mile 42 from the head of the canal, the Ching Lung Wan has two outlets.

1. Tung Yin Ho.
2. Tseng Kou Ho,

Both of these outlets join the Pei Tang Ho or Chi Yun Ho at different points.

The Tung Yin Ho used to be the only outlet of the Ching Lung Wan and is the most direct to the sea. But the people of Pan Erh Chuang, finding that the salt water from the tides twice a day a drawback to their crops, built a dam across the Tung Yin Ho at Lu Hsian Chuang (樂善亭) in order to stop the sea waters from coming into their farms. No doubt it worked out all right as far as the tide was concerned, but they did not consider that this dam hindered the discharge of the canal waters to the sea and in consequence the Tung Yin Ho was silted up above and below this dam.

The Tseng Kou Ho is part of the canal connecting the Chi Li Hai to Chih Yun Ho, between Tientsin and Lu Ta. When the Tung Yin Ho was blocked up, the waters from Ching Lung Wan naturally takes this canal to Chi Yun Ho. The lower part of Chi Yun

Conservancy Offices to protect the bend, the flood completely destroyed this weir on the 26th July 1917. This was the last attempt to stop the water from going to the Chien Kan Ho. The only way to divert the waters back to Pei Ho again is by making a cutting at Niu Mu Tun, which will lead the waters of Chien Kan Ho to Pei Yun Ho, as beds of Chien Kan Ho and Pei Yun Ho near Niu Mu Tun are practical on the same elevation this will make it possible. When this cutting is made all the Pei Ho waters will come down to the Hai Ho again, via the Chien Kan Ho and the Cutting.

In this survey a line was run along the Chien Kan Ho immediately above Niu Mu Tun, for some miles and then 2 alternative lines were run from the Chien Kan Ho to connect the main line on the Pei Ho, these were the shortest lines for the cutting. In all the surveys from the start up to Yang Tsun via the Ching Lung Wan and Wu Kung Ho canals the method adopted was according to the "General Instruction" of the Chief Engineer, viz: 2000 ft. offset lines at 1000 ft. interval with level at every 100 ft. on the centre line and 500 ft. on the offset lines, and topography taken by stadia from these offsets. After the survey of the proposed cutting was completed the centre line on the Pei Ho was extended to the north as far as Ma Tou Cheng where the river has a definite channel and then to the south as far as Ho Hsi Wu. This survey was to include all the area between the dykes. These dykes were often much more than 4000 ft. apart, and the Chief of Party was especially told to exceed the 4000 feet limit in order to get the ground level outside the dyke. Every detail is shown on the maps and profiles and cross-sections of the rivers was also plotted.

North of Ho Hsi Wu the Ching Lung Wan Canal leaves the Pei Yun Ho to the south east. That this canal was originally intended for flood discharge may be proved by the weir that was built at the time of Chien Lung (see detail map). The whole canal is pretty straight and the dykes are close to each other and very regular about 900 ft. apart, up to Ta Pai Chuang, mile 30, and its height

THE PEI YUN HO.

The 2nd party was instructed to begin the survey of the Pei Yun Ho at a point nearest to the proposed Niu Mu Tun Cutting. Niu Mu Tun is a small village situated midway between Chien Kan Ho and Pei Ho about 80 li south east of Tung Chow. It may not be out of place to give a brief account of the proposed Niu Mu Tun Cutting.

In 1912, when the Pei Ho first changed its course by breaking the dyke at Li Sui Chen, the water found its way to the sea, via the old bed of the Chien Kan Ho and Chi Yun Ho instead of the Hai Ho. As the Chien Kan Ho is more or less a creek, this enormous volume of the Pei Ho water coming down by its unprotected and undyked channel devastated all the surrounding districts. Attempts were made by the authorities concerned to stop the waters from going into the Chien Kan Ho by repairing the breaks. All went well for the time being, but in the following autumn another freshet broke it again for the second time when the river made such a channel for itself that there is no means of preventing the water from taking this new course.

The advantages of reverting the Pei Yun Ho waters to its own course are.

1. To prevent those regions traversed by the Chien Kan Ho from inundation, the sufferings from which are too well known to be commented here.

2. To safeguard the navigability of the Hai Ho.

Every body knows that the five great rivers of Chihli empty their waters into the Hai Ho but few realize that the waters of one river may be welcome and another may not. All the river waters are silt laden in varying degrees, but Pei Yun Ho is comparatively the least silt laden. That is why the Hai Ho Conservancy insisted on having the Pei Yun Ho waters reverted to its "status quo ante". In October 1916, the reversion of Pei Yun Ho was carried out and the building of a weir at Hu Chwang was completed in 20th May 1917. But owing to the negligence on the part of the Pei Yun Ho

east for about 20 miles; This is itself a great advantage: Another advantage is that the cost of the land through which the line passed is very cheap, the average price is about \$ 7.00 per mou, and there is no valuable properties to be considered, as nearly all the land are reed farms. This part of the country is also very flat. Generally no ground is higher than the other by more than 2 ft. At mile 20 the line passed south of Chi Li Hai (七里海), which was once a lake but its bottom has been raised up by silt to the same level as the surrounding country. And continuing eastward, the line crossed the Tung Yin Ho and Chi Yun Ho, which are outlets of the Ching Lung Wan and Chien Kan Ho respectively, and the Peking Mukden Railway at Han Ku. Hence the centre line inclined to the south east through the salt fields of Han Ku to the sea. Throughout the entire length, the ground level varies very slightly. From Pei Yun Ho to the sea the ground except the first 2 miles, has no appreciable fall to speak of. For instance.

Elevation of top of dyke at mile	0=	28.42
Actual Ground Level at	„	1=15.
Average „ „ „	„	5= 8.27
„ „ „ „	„	10= 7.54
„ „ „ „	„	15= 9.05
„ „ „ „	„	20= 8.53
„ „ „ „	„	25= 7.51
„ „ „ „	„	30= 7.99
„ „ „ „	„	35=10.73
„ „ „ „	„	40= 9.53
Elevation at end of the line	„	45= 9.12
At sea shore	„	48= 4.94

Thus it can be seen that the ground from Pei Yun Ho to the sea has no natural slope. This is one of the important point to be kept in mind when a new outlet for the Yung Ting Ho is being considered.

The 2nd half was assigned to the 2nd party for the same reason that they had surveyed the Wu Kung Ho already and this line to be run was just between the Wu Kung Ho and line already surveyed by the 1st party. By doing so, the whole area from Pei Yun Ho to the sea with Wu Kung Ho on the north and the Chin Chung Ho on the south, will be covered by these surveys.

The methods adopted for this survey is the same for both parties, a centre line very accurately chained and levelled every 100 ft. with offsets of 8000 ft. in length at 8000 ft. interval, these offsets are levelled every 500 ft. and sometimes they may go beyond the limit in order to obtain some important topographical features or they may be shorter if the country appear level beyond certain point.

From Kuo Chia Wu to Pei Yun Ho the line, except for the first 3 miles along the Pei Yun Ho, was directed to the east. The total length of the line is 32 miles, the country has a natural fall from the west to the east (i. e. from the head of the delta up to Pei Yun Ho) and the ground within the 3 miles surveyed may be called flat, because it has no abrupt change in the level, in these offsets of 8000 ft. the difference of elevation seldom exceeds 2 ft.

The ground slope from Kuo Chia Wu to Pei Yun Ho may be seen from the following :

Elevation of ground level at Kuo Chia Wu	...	...	61.
Elevation of ground level at Pei Yun Ho	...	...	19.
Total fall for a distance of approximately 30 miles.	...	...	<u>42.</u>

Gradient of ground level is approximately 1 : 3500.

The starting point for the 2nd half of this survey for the alternative route of the Yung Ting Ho outlet was selected by the 2nd party at a place some five and half miles below Yang Tsun between the village of Han Kou (漢溝) and Lang Yuan (廊園). The line passed through open uncultivated land in a south eastern direction for the first five miles and after that it is a long straight tangent to the

The line taken by the first party was to continue from Chu Chia Tien (the end of the line on the delta) toward the sea in an easterly direction. It passes south of Pei Tsang Station of the Peking Mukden Railway, and through Ta Ho Tien, a plot of swamp land known as French marsh extending over an area of 40 square miles and from 1 to 2 miles north of the Chin Chung Ho all the way up to Pei Tang.

The method of this survey is a little different, the centre line is chained and levelled as before but the offsets are 8000 ft. long, instead of 2000 ft. as before. These are taken at 8000 ft. interval, and topography taken 500 ft. on each side of the centre line.

The total length of this line from Chu Chia Tien to Pei Tang is about 38 miles. Except the first ten miles (up to Ta Ho Tien) which is well cultivated the line passed through swamp lands where reeds are grown, these reed farms supply the people of Tientsin with fire wood. The whole country passed is very flat, except that Ta Ho Tien is about 3 feet below the average ground level. There is no fall from Pei Yun Ho to the sea. This is one of the most important questions to be settled in the designing of the outlet for the Yung Ting Ho.

The line H was a tie line from the last point of the 1st party to the 2nd party and accidentally it took in the whole of the lower course of the Chi Yun Ho which is the outlet of the Chien Kan Ho and Ching Lung Wan. The lower course has very many bends. The whole country but for the river is very flat from Pei Tang to Han Ku

By order of the Director-General an alternative line for an outlet for the Yung Ting Ho was surveyed. This is to provide an entirely new channel for the Yung Ting Ho from the head of the delta direct to the sea by the shortest possible route.

This survey is made up of 2 portions.

The 1st portion from Kuo Chia Wu to Pei Yun Ho.

The 2nd portion from Pei Yun Ho to the sea.

The 1st half was undertaken by the 1st party because they were familiar with the conditions in the delta and knew where they had surveyed up to before, so that the work would not be overlapped.

Lung Feng Ch'iao (the outlet of the confluent of Lung Ho and Feng Ho to the Pei Ho) was chosen as the starting point for this survey. Such a landmark would be easy for the 2nd party to find when they came down from Yang Tsun as they were told to do so in order to tie on to the first party.

The Pei Yun Ho as every one knows is a part of the Grand Canal from Hang Chow (杭州) in the extreme south and Tung Chow (通州) in the north and before the introduction of steam locomotive to China the traffic in the Canal was very heavy. The dykes from Lung Feng Ch'iao to Hsi Ku, are all maintained in very good condition, the width at the top is about 20 feet, the average height is about 15 feet above the ground level, the distance between the dykes vary from 200 ft. at the narrowest point to 2000 ft. at the widest. The general course of the river up to Tientsin is in a southern direction, although the river flows in all points of the compass in their bends.

The gradient of the river-bed is very gentle, it has a fall of about 1 foot in 2 miles. The elevation of the bottom of the river near Tientsin is 0 Taku Datum i.e. on the same level as the low tide at Taku.

At present the Yung Ting Ho empties itself into the Pei Yun Ho by two channels near Ch'u Chia Tien (屈家店), which are about one mile apart.

The 3rd last portion of the Yung Ting Ho survey is to locate a possible and the most economical outlet for the Yung Ting Ho from Pei Yun Ho to the sea. Many people have proposed and some have advocated that the Chin Chung Ho should be used as an outlet for the Yung Ting Ho by making a cutting at Ta Ho Tien. It seems to be quite feasible by merely looking at the map. But a careful study on the condition of the Chin Chung Ho from the data obtained from its surveys will prove that it is inadequate to serve as an outlet for the Yung Ting Ho unless an enormous sum of money is spent on its improvement in a large scale.

(8)

Elevation of river bed at Kuo Chia Wu	= 70.00
Elevation of river bed at Junction with Pei Yun Ho	= <u>13.00</u>
Vertical fall in feet	= 57.00
Distance from Kuo Chia Wu to Junction	= 195000 feet
Gradient of river bed surveyed	= $\frac{57}{195000}$ or 1:3430

A number of auxiliary lines in the delta were also surveyed
They were as follows :—

Line	Description	Method of Survey.
A.	Curved dyke and north main dyke.	Centre line with transit, level & stadia measurement along the dyke.
B.	South curved dyke.	Centre line with transit, level & chain measurement.
C.	Old channel.	Centre line with transit, level & chain measurement.
D.	New channel.	Centre line with transit, level & chain measurement.
E.	Ice area.	Centre line with transit, level & stadia measurement.
F.	North main dyke.	Centre line with transit, level & chain measurement.

During the autumn flood of 1917 the waters made a new channel from Chin Chuang to Shuang Kou (雙口) as indicated by the line D, which was run on the ice, when the survey was made.

As the Yung Ting Ho has to pass the Pei Yun Ho on its way to the sea it is necessary to choose a suitable junction for the crossing. For this purpose a section of the Pei Yun Ho from Yang Tsun to Hsi Ku, a distance of about 22 miles, was carefully surveyed. The method adopted was the same as before, viz:- a transit line with offset 2000 ft. in length at 1000 ft. interval. The topography within the 4000 ft. was taken by stadia and offsets were levelled and soundings taken when they were on the river.

the worst part of the whole delta, it is like a desert, no living can be found anywhere.

At Nan Ti Wu (南第五) mile 11 from Kuo Chia Wu the dykes no longer continue to be parallel, but abruptly turn away from each other, and from this point the transit line ran on the actual ground level instead of on the top or along the dykes as before.

At Ta Chin Chuang (大甄庄) mile 18, the river has no permanent bed, and the dykes are too far apart, the whole district at this point being very low was covered by ice. On the north of the village a small channel was made by the water itself, this channel is very easily choked up again. On the south side of Ta Chin Tsun (大甄庄) the whole country was flooded for several miles.

The channel of the river from this point onward is very narrow and the bottom is only a few feet below the ground level. At Ko Yu Cheng (葛漁城) mile 20, the water flowed in a southern direction, passing close by the village. On account of the flood last year which endangered their homes and properties the people of this village dug a new channel for the river eastward to divert the water from coming down to devastate their homes and spoil their harvest.

At Shih Ke Chuang (石各庄) mile 25, this channel was again separated into two and as the country is very low and flat and the channels are narrow and shallow the river water easily overflowed in the raining season.

The country south of Yu Pa Kuo (魚壩口) mile 31, up to Pei Yun Ho is a low-lying country, it was flooded not only from the water of Yung Ting Ho, but also from the waters of Lung Ho and Feng Ho (龍鳳河) and Pei Ho, whose waters back up at their junction.

The following shows the fall between the two extremities.

The river on this portion between Lu Kou Ch'iao to the delta is confined in its channel by dykes, and as the river-bed is higher than the adjacent country, the latter is liable to be inundated at any time, should a break occur, the authorities have to spend a large sum of money annually for the maintenance and up-keep of these dykes, not to mention the cost of repairs in time of breaks.

Between the Pei Ho on the east and Yung Tsing Hsien on the west the river has no permanent channel, this area is known as the "Hun Ho Delta". The survey of this delta was entrusted to the 1st party. A traverse line was run by following the present main channel of the river with offsets of 2000 ft. at an interval of 1000 ft. on the main line. At every 500 ft. on these offsets stadia notes are taken. Thus every detail of the topography of a strip of land 4000 ft. wide is recorded.

Levels were taken at every 100 ft. on the main line and every 500 ft. on the offset lines. The main line level is checked by another level party and Bench Marks were established at about every 2000 ft. apart.

From Kuo Chia Wu, the starting point, to Pei Liu Tu (北柳坨) mile 10 the river is still confined to its channel by dykes at 2000 to 3000 ft. apart. The whole bed between the dykes except the actual present channel is silted up. The average height of the dykes above the ground level outside the dyke is 20 ft. and the silt within the dykes is only a few feet below the top of dyke. The northern dyke from Tung Chia Wu, (董家務) mile 3, to Shuang Tu Ying (雙渡營) mile 6, were in a very precarious condition, not only because they were built of earth, but the country outside the dykes is also much lower than the average, at some places it was 30 ft. below the top of the dyke, and the dyke is only a few feet above the silted bed of the river, so a smaller dyke is piled on the top of the dyke this is known as Nien (稔), the width on the top of the dyke is about 20 ft. The country east of the northern dyke at this point is

THE SURVEYS**The Yung Ting Ho or Hun Ho.**

The survey of this river was made by several parties and in different ways therefore it can be best dealt with in the following order according to the manner in which the section was surveyed.

- 1st from Lu Kou Ch'iao to Kuo Chia Wu (Head of Hun Ho Delta).
- 2nd from Kuo Chia Wu to Pei Yun Ho.
- 3rd from Pei Yun Ho to the sea.

Firstly, the survey of the 1st portion was undertaken by the 4th party (Precise Level). The primary object of this survey was to verify the Bench Marks on the upper course of the Yung Ting Ho from Lu Kou Ch'iao downward and to tie on to the starting point of the 1st party (This levelling was not mentioned in the recommendation of the Sub-committee) and secondly to find approximately the gradient of the river bed. A line of levels was run from Lu Kou Ch'iao down to Kuo Chia Wu by following the river and checked by repetition. The distance were measured by stadia and bearings taken with a military transit. A number of cross sections of the river channels was also taken at intervals. From these cross sections the distances between these dykes are known, they vary from $\frac{1}{2}$ to 3 miles and the fall of the river may also be found. Thus the total distance from Lu Kou Ch'iao to Kuo Chia Wu is roughly 49 miles and the elevation at these two places are as follows ;

Elevation of bed of river at Lu Kou Ch'iao = 191.5

Elevation of bed of river at Kuo Chia Wu = 69.0

The total vertical fall in feet for the distance
of 48.95 miles 122.5

The gradient of the river bed between Lu
Kou Ch'iao and Kuo Chia Wu is roughly 1 : 2000.

TIME TAKEN	Total Mileage of Main Line.	REMARKS.
Party 1. Jan. 17 to May 10.	252.95	115.19 miles Traverse line. 83.26 miles of 16000' wide. 54.50 miles of 4000' wide.
Party 2. Jan. 16 to Apr. 30.	242.08	9.92 miles Traverse line. 48.34 miles of 16000' wide. 148.71 miles of 4000' wide. 35.06 miles Ta Tsing Ho.
Party 3. Jan. 16 to May 2.	237.27	17.21 miles Traverse line. 83.02 miles of 4000' wide. 137.04 miles of 16000' wide.
Party 4. Jan. 16 to May 13.	182.16	Precise Level. 53.88 miles on Yung Ting Ho. 85.94 miles on Grand Canal. 42.34 miles from Taku to Red Bridge.

The time taken is reckoned from the day the party left Tientsin until the day of their arrival.

I have the honour to be,

Your Excellency's

Most obedient servant

F. F. YAP.

Tientsin, August 1918.

- 1 Chief of Party & Leveller,
- 1 Cadet,
- 1 Deputy.

This party was not included in the recommendations of the Sub-committee, nor were the surveys specified in these recommendations. The work done by this party was to verify the value of old established Bench Marks, and to check the Bench Marks established by the various parties and it will be described later in its own place.

The surveying instruments and other accessories, which were ordered from Shanghai by the Chief Engineer, arrived on the 9th January but were kept in custody at the Native Customs in the Central Station for three days, because the special messenger who brought them from Shanghai did not have a passport for delivery in Tientsin, with the arrival of these instruments, and the field outfits having been previously purchased locally, every thing for the comfort of the party was ready for the field. Each party was furnished with camp beds, Hurricane lamps, heating stoves, cooking stoves, stationeries and a small medicine chest for emergency.

In spite of the depth of the winter in the north when the parties first set out for the field (the majority of the members of the field parties were southerners) they were favored with good weather, excepting a day or two of snow and sand storm when accurate instrument work were impossible, the surveying were not hindered in the least, and moreover most of the river were frozen; which is a great advantage and afforded more facilities to the field men.

The following table shows the total mileage of Transit line done by each party.

were sent to the Director-General for sanction and appointment. These were

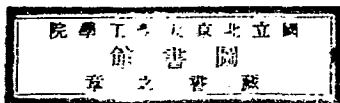
1. Yung Ting Ho Party,
2. Pei Yun Ho Party,
3. Tzu Ya Ho Party,
4. Precise Level Party.

The Personnel of the first three parties were the same, each consisting of 14 members, namely:—

- 1 Chief of Party,
- 1 Assistant Chief of Party.
- 7 Instrumentmen,
- 3 Cadets,
- 1 Deputy & Cashier,
- 1 Information Cadet.

The last two received their appointment direct from the Director General. The duty of the Deputy was to arrange transportation and to seek lodgings for the party and as a Cashier, he was responsible for all the money sent to him and he paid the salaries and allowances of engineer in the field and defrayed all other incidental expenses of his party. The Information Cadet was a man who has a good knowledge of the river which his party was going to survey. His duty was to assist the Chief of the Party to find out the old Bench Marks established by the River Survey Bureau of the Province, (as these Information Cadets used to work for the said Bureau), and gave him the general information of the locality through which the Party was likely to pass.

The Precise Level Party were composed of only three members, namely:-



Report on the Surveys
OF
YUNG TING HO, PEI YUN HO, AND TZU YA HO
BY THE
Survey Bureau of the Flood Relief and Conservancy.

To

H. E. HSIUNG HSI-LING,

The Director General

Flood Relief and Conservancy.

Your Excellency,

In accordance with your instruction I have the honour to submit herewith to Your Excellency the following report on the surveys of certain rivers in this province recently made under the direction of Mr. C. D. Jameson, the Chief Engineer. Before going into details and results of these surveys, permit me to give a resume of the organization of the survey department and the appointment of its Chief Engineer and staff.

The Chief Engineer was appointed at the beginning of December by the Director-General according to the Recommendation of the Sub-Committee of the Committee for the Study of Conservancy on the surveys of the above mentioned rivers.

The Bureau was located in Hopei near the Directorate General. The office staff consisted of the Chief Assistant, an Accountant and an Accountant Clerk, a Chief Translator, an English Clerk and Typist, a Chinese Clerk and a Store Keeper.

On the 2nd of January the Chief Engineer came down from Peking with his survey parties. The list of members of these parties

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Directorate General of Flood Relief
and Conservancy.



Report on the Surveys

OF

YUNG TING HO, PEI YUN HO, & TZU YA HO

by

F. F. YAP, B. Sc. (*Edin*)

Chief Assistant Engineer

Survey Bureau

Tientsin 8th. August 1918.

