USACE ERDC

Moderator: Julie Marcy
Speaker – Tim Welp
December 4, 2013
DOTS – An Overview of Dredging Equipment and Methodologies

Julie Marcy: Welcome everyone. This is Julie Marcy with the Engineer Research and Development Center's Environmental Lab in Vicksburg, Mississippi.

Julie Marcy: I'll be serving as your host today. At this time, I'm going to activate the listen only feature to reduce some background noise on our call, so if you hear a tone, that's what it is. It'll be just a moment.

Operator: All participants are now in listen only mode.

Julie Marcy: You have joined us for the Dredging Operations Technical Support or DOTS Webinar series. This series of Web meetings is intended to share topics of concern on the national dredging program. The Web meetings are recorded and archived files are posted on the DOTS resource tab. That URL or address is shown on the introductory slide that you should be seeing on your screen.

Just a few etiquette notes before we begin today's session. As a courtesy, we have the background listen only feature activated. But when we do go into our question and answer session later, please keep your phones on mute when you're not speaking to try to reduce the noise.

If you have a question during the presentation, you can use the chat feature to send a question in. It's helpful if you'd send that to all participants so that we

can see what the question is and I'll periodically interject into Tim's presentation and let him know if a question has appeared.

You can also use the raised hand feature that's available in Webex if you have a question to ask. Most of our questions will be covered at the end when we'll open the floor to a general question and answer session and I'll return everyone to the interactive mode at that time.

Remember not to put us on background music, on hold, because that can be rather distracting. And as I mentioned to several of you as we were beginning to start earlier, if your name, your full name and organization are not already apparent in the participant's listing, if you would take just a moment to use the chat and send me, Julie Marcy, your host, that information, that helps us track who our Webinar participants are and is very helpful.

So, for example, you might put, (Joe Smith), SWD or Southwestern Division five attendees, that type of information. And with that, I'll give you today's speaker on an overview of dredging equipment and methodologies, Tim Welp.

Tim is a research hydraulic engineer in the Engineer Research and Development Center's Coastal and Hydraulics lab. Tim has a Bachelor's of Science degree in mining engineering and a Master of Science degree in ocean engineering.

He has a diverse work background including work in coal and gypsum mines, doing research in dredging equipment optimization and beneficial uses of dredged material for the Corps, the Army, Navy, Department of Defense, EPA, the World Bank and the private sector.

He has over 30 dredging publications and book chapters and he currently serves as committee chair for the Coast, Oceans, Ports and Rivers Institute Waterways committee.

Tim also serves on the editorial board for the Journal of Dredging Engineering. If you want to see additional details about Tim's distinguished background, you may see them in his bio that's posted on the DOTS page.

We'll be posting that, along with a copy of the Power Point that he'll be sharing with us today. And after the presentation, we'll be posting an archive of the video recording of the presentation along with the transcript of the presentation.

As you can see, Tim is a very distinguished researcher and we're very fortunate to have him with us. And with that, Tim, I'm going to assign you presenter rights and turn the presentation over to you.

Tim Welp: All right, Julie, do you read me?

Julie Marcy: I can hear you fine.

Tim Welp: All right. Thank you for that fine introduction. Good day everyone. As Julie said, my name is Tim Welp and today I'll be your guide on this overview of dredging equipment methodologies, or in other words, I'll be talking about the different kinds of dredging hardware that's out there and how it works.

Now this is the seventh installment of the DOTS Webinar series and I'll be touching on some of the points made during the previous Webinars that were given that address the National Dredging Program, beneficial use of dredge material, Engineering with Nature and dredging operations.

Now, on Tom Verna's)'s presentation on dredging operations Webinar, he defined dredging as the process of excavating sediments and other materials from underwater locations that - and it includes the transportation and the placement of this material and is used for an application such as constructing new waterways, maintaining existing waterways or obtaining fills for purposes like land reclamation, beach nourishment, et cetera.

Now a dredge is basically a sediment management machine and in sediment management, you usually have too much or not enough sediment. Now my supposition to you today is that in the past, we've either focused on the navigation or having too much sediment as illustrated on this cartoon where the gentlemen is standing in the center line of one of the Corps navigation channels that shall not be named.

Or we focus too much on going out and dredging material from borrow sites to place that sediment where we don't have enough. Now, as Todd Bridges said on his Webinar on Engineering with Nature. The Corps, we're changing the way that we approach dredging projects. We're starting to look harder for those dredging solutions that land in that sweet spot that's common to the three spheres of society, the environment and economics.

And so we're starting to use the word, "and," more that links navigation dredging to the beneficial use of that dredging material. And by doing so, we can strike a more sustainable balance. Now, for this presentation, I'm going to break down the general dredging process in the four stages that you see on the slide basically - excavating the sediment from the bottom, bringing it up to the dredge vessel, transporting the material to the placement site and placing that material.

And then - and I say general because not all dredging technologies have those four stages and I'll be pointing out some of these differences later in the presentation and hopefully throughout this presentation, I can illustrate the aspects of different dredging equipment and methodologies that can help us achieve that sustainable balance I was talking about.

And, oh yes, as a footnote, I'd like to mention that in the regulatory realm, dredging and placement are two separate activities each with its own subsequent ramifications.

Now on this slide, this next slide, I'd like to start out with giving some dredging definitions, starting with sediment, being that unconsolidated material like sand, silt or clay that lies at the bottom of the channel.

And so after the dredge comes along, picks it up, moves that sediment, it becomes dredge material. And like (Tom Verna) said in his Webinar in the past, we used to call dredge material spoil.

The use of this term is not recommended. It's bad, bad, bad. Please don't say the word spoil in the crowd because if you do, you'll stand out like a Pilgrim in the wasteland not knowing what you're doing.

Now regarding the term disposal site, I'm starting to see more and more people and myself included, starting to use it. I'm trying to replace the word disposal or dispose with placement or placing and it's to get away from the negative connotations of along the lines of, you know, you dispose of trash but you place a resource.

And now the word - the term dumping. I've included this in the list and, use it like in dumping dredge material offshore, and I've had people tell me that I'm

not supposed to use it but the mining engineering in me, I just can't let it go because I like my dump trucks and my bottom dump doors and hoppers, et cetera, et cetera.

So during this presentation, in the chat, or during the question session afterwards, I'll throw this out to you, the audience. Should we keep the terms dump, dumping and dumped or is it too much?

And then I also included the term the dredge plant because sometimes people don't know what we're referring to. It's not a hibiscus plant growing on a flying bridge of a hopper dredge? But rather it includes the dredge itself proper and all the supporting equipment and intended vessels like tugs, anchor barges, et cetera.

And last but not least, I included the term environmental dredging and I'll define it as the removal of contaminated sediments from a water body for remediation purposes. And I'm giving this presentation today from a navigation dredging perspective.

And while the dredging fundamentals are basically the same for environmental dredging as navigation dredging, there can be big differences in how certain related aspects are emphasized. Like, say for instance, how important is the dredge sediment resuspension characteristics? And that can cost you bigger bucks in the environmental realm.

And the document you see here, you might not be able to see it, but it's a reference but it's "Technical Guidelines for Environmental Dredging for Contaminated Sediments." It's an excellent document that describes these differences in detail.

And like (Joe Wilson) said in his Webinar, only 3% to 5% of what the Corps dredges requires special handling anyway. Now in the next two slides, I'd like to give you a real brief history of the development of dredging. And the reason I'm doing this is to try to illustrate that while the practice of dredging has changed, the fundamentals haven't.

Something along the lines of "what is has already been or what will be already is." Or if that's too much off on a tangent, in other words, what I'd like to do is paraphrase what (Tom Turner) said in his, "Fundamentals of Hydraulic Dredging," textbook, that the comprehension of dredging fundamentals is essential because over the long run, principles will always win out over practice because the principles never change and practice must change as a function of available equipment, instrumentation and controls.

So I'll start by going back a thousand years, a couple thousand years ago when all the great civilizations were founded around the water bodies, the Egyptians on the Nile, Fertile Crescent between the Tigris and the Euphrates Rivers, et cetera.

And these people had to deal with shoaling in some manner, like navigation or shoaling up the irrigation channels. Some authors have hypothesized dredging could have been something as simple as dragging a water soaked log along the bottom to resuspend the sediment and have the current take that sediment away.

On this slide, I've got two Chinese dredging technologies and I hope you can see the cursor, the technology in the upper right hand corner. But this is an ancestor of the clamshell and this is circa about 1071.

You can see basically kind of like a drag line or a clamshell but this bottom technology, that's my favorite. They called it the Iron Dragon law Silt Dispersing Machine and it's designed to be towed by two boats and be pulled along the bottom of the channel to resuspend the sediment up into the water column so ambient currents will take it away.

And this was technology from approximately one millennium ago. Now in this slide, I'm going to kind of go fast forward on a dredging time machine to the 1400s and forgive the pun, but I don't have the time to get into much detail.

But what I wanted you to see in this graphic is the general development trend and these graphics were generously supplied by Dr. (Bob Randall) at Texas A&M Centers for Dredging Studies. But just - to see the trend of, like, starting around the 1400s, that's a spoon and bag dredger that is man powered.

I would go over to the sailing vessel, the Kraggelaar or water harrow that the sail powered but had rakes on her keel, drag along the bottom and re-suspend the sediment and put it up in the water column. Then there's the Amsterdam mud mill, man powered, turned the hamster wheel, and endless bucket chain that bring sediment up and dump it off into the scow that was tied to the stern.

Then 100 years ago, approximately, it went from man powered to horse powered. You see an early precursor to the clamshell. And then what we start to see is that we had the confluence of the development of centrifugal pump around the early 1700s and the invention of the steam engine in the 18th century.

And the Army Corps of Engineers developed the first hopper dredge and they used it back in 1855, the General Moultrie and this is the picture of the Henry

Berden that was used about a decade later because the General Moultrie was lost in the Civil War.

But this is when the production rates really started to go up and were being able to move more massive amounts of sediment quicker. Here's a steam show, a suction dredge, a British suction dredge used in the Suez in 1872.

And then here's another Corps invention and the Dustpan dredge was used back in the 1800s and it was steam driven and it was designed specifically for the Mississippi River.

And then as we fast forward and actually in 1906, there was an electric motor used in the dredge, and then around 1922, diesel engines started to hit the scene and we've never gone back.

So fast forward to today, the vast majority of dredges are diesel engine driven but you can see a pattern here and we go from manpower to mechanical dredges and literally into the horsepower in the mud mill and the steam powered hydraulic mechanical dredges.

They're, in turn, replaced by diesel and electric power, mechanical and hydraulic dredges. And what we're going to do is break down our basic classifications into those two primary components - mechanical dredge and hydraulic dredge.

So mechanical dredge is a clamshell or a backhoe that's connected rigidly or by wire cable to the derrick barge, and hydraulic dredge is a floating machine that excavates the material by entraining it into a slurry and then it transports it into the pipeline hydraulic circuit.

And now there're several variations of hydraulic dredge and it's kind of broken down into the way that that specific dredge transports material like through a pipeline and includes both cutter head and dustpan and a hopper dredge that transports material offsite on the hopper or side caster where it picks up the material off the bottom and puts it out through a casting boom off to the side of the channel.

I've included this graphic here just to give you an idea of the respective types of dredge used for the volume of material that the Corps moves. pipeline and dustpan together. Over 50% of the dredging we do is by pipeline dredge. Hopper comes next, around 30-plus percent and then mechanical dredging.

And then we'll also be talking about some other combinations of different types of dredges that kind of combine some of these basic fundamentals together. And some of the factors that are used in the selection of dredging equipment, what kind of material are you going to be dredging?

What are the quantities? How deep is it? What's the distance to the placement area? And what's the environment between the dredging and placement site, the level of contamination of the sediment. How are you placing that sediment and what kind of production are you requiring in case you've got to work in between environmental windows?

And those are really the types of dredges that are available for you to use in the first place. Now we'll start out with clamshell mechanical dredge or a bucket dredge. This is a clamshell bucket connected with a wire rope cable to the (derrick) barge and the crane.

The bucket grabs the sediment. They bring it up, slew it over the barge and drop the sediment into the barge. Here's a picture from the stern and it'll

maintain position by three spuds, two forward, one aft and, like you can see here, they have a scow or barge port and starboard.

So the one on the port is full, low in the water line, so a tug will come in, take this barge away and the crane operator can start filling the other barge immediately so basically you have a continuous dredging, relatively continuous dredging cycle.

And here's just an illustration to give you an idea of what the clamshell is like biting into the sediment on the bottom. It's a function of the configuration of the bucket, its weight, how fast the operator drops it, and you can see a relatively - a fair amount of sediment resuspension. Now this is - I put this in here because up on the upper left hand corner, like I said, I hope you can see the cursor...

Julie Marcy: We can, Tim.

Tim Welp: Roger that. Thank you. Use a cross section or a channel template, side slopes, channel toe, and the middle of the channel. We have to excavate our channels down to the required depth but every type of dredge has to dig a little bit deeper than that required depth in order to make that depth.

So most of the time we give them allowable over depth that they dig just a little bit deeper. No dredge will leave a pool table flat bottom in your channel.

Here's the full coverage - this is a multi-beam bathymetric survey of the channel bottom that was left from a clamshell dredge and you can see the toes here of the channel that's leaving a scalloped pattern that you can envision that bucket going down and taking out that sediment as it slews back and forth.

Here's a picture of a conventional bucket with teeth with an open face at the top and there's been an environmental or a closed bucket developed out there. Here's one of the navigation buckets used. And, between 5 and 30 cubic yards is kind of common out in the industry and it just came out with a 60 cubic yard bucket as well.

And because the sediment is excavated in that bite, you can - or depending on the sediment, of course, but you can excavate that sediment at in situ or near in situ density of the channel itself.

The type of mechanical dredge is the backhoe and it's another bucket but this is where the bucket is connected to the dredge vessel by rigid structural components, the boom and stick of the excavator.

The operator will lower the bucket down to the bottom and what he'll do is he'll knuckle over the bucket, grab a bite of sediment, bring it to the surface, slew over and place it into the barge.

Now once the barge is full, they take it off and then they'll discharge the material, place material, if you will, and it can either be through a split hull scow, drops down by gravity feed or some barges are bottom dump door where you can see it but there're just doors on the bottom that opens up and the sediment falls through.

Or you can mechanically offload it, like, say with another clamshell or they also have what's called a hydraulic off-loader and these can be submersible pumps or jet pumps. But what they do is they'll bring the loaded barge in alongside the hydraulic off-loader and lower the pump down into the material and they'll have to re-fluidize. They have to - well, if the material doesn't

have enough water already in it, they re-fluidize that material and they'll pump it out through a discharge line on to the placement site.

The advantages of mechanical dredges, they're rugged and they're capable of removing relatively hard packed material. The backhoe dredge generally can take out more consolidated material than the clamshell. It can remove debris because you've got that bucket that can close around something that's small enough to fit in between the closing edges.

It can work tight areas, have relatively precise excavation and because they can fill up one barge and then move right next to the next one if they have it, it's efficent for disposal of long haul distances.

Some of the limitations are that if you're dredging real loose, fine material, have an open faced bucket or you're in an enclosed bucket, you can get a relatively, you can get a fair amount of sediment coming out resuspended.

The production rate is relatively low compared to pipeline dredges and you can get - if you have a large content of debris, if that bucket closes, the closing edges close around a stump or something, you have fine grain material. a lot of material can fall out as the bucket is being raised.

Next we're going to move on to the hydraulic pipeline or the cutter head dredge. this is the most common in dredge in America. There're hundreds in the US. The size, how you classify a cutter head dredge or a pipeline dredge is based on the size of its discharge line.

And in Corps projects, a small dredge, real small is, like, 10, 12 inches, go up to about 36 inch inside diameter and around 20, 24 is considered a large dredge.

Production rates, when I'm talking production rates during this presentation, rules of thumb, because production rates depend on a vast array of dependent and independent variables but I just - I want to give you an idea of just an approximate horseback rule of thumb type of production rate.

In really, really good conditions, you can get maybe 3000, 4000 cubic yards an hour with this type of dredge. The cutter head rotates, material comes up through the ladder or suction pump. Some dredges had submersible ladder pumps on them where other dredges have a hull pump.

And the material will go up and be pumped out through the pipeline dredge and out through the discharge line. And what you see here is they'll drop the spuds down - a spud down into the bottom and it'll rotate around that spud like you'll see in this picture because this is a conventional dual spud arrangement.

And one spud will be down and you'll set out two swing anchors and they'll take in the wire rope on one anchor and let out on the other. The dredge will swing back and forth and because the spuds are offset, they drop the advancing spud and the dredge advances in that manner.

And here's just a picture of one of the Great Lakes cutter heads. The pick points could be used in rock for weak limestone, et cetera, and this is just a cartoon. Some people think when that cutter head's rotating and it's function is to dislodge the material and also feed the suction but they think it's like an egg beater or a puree or something but, these average RPMs on the cutter head can be around 30 RPM or so.

And here you can see that dredge swinging back and forth, letting the tension out, taking the tension on the opposing swing wire and the dredge advances in that manner.

Now, just, we can take a little tour. This is the Corps cutter head dredge Goetz. It's a 22 inch dredge in the St. Paul district. And what we're going to do is we're going to start the tour up in the lever room. And the lever room is a relic from the early days where the dredges had mechanical controls and here you can see the levers that the lever man - it's called leverman - would use to operate the dredge.

And now I'll flash forward to modern day Goetz lever room and here we have a more contemporary updated lever woman, if you will, and you can see by her joystick that the stage of development for the instrumentation on these dredges has really advanced and especially with the computers.

Over the last 20 years it's been phenomenal, not only in the controls but also in the instrumentation required to be able to monitor, like, the XYZ position of the cutter head or the slurry density of velocity going through the pipeline in all these forms of control the dictate the state of practice of the dredge technology.

So she looks out through the window here. She'll look down and she'll see the A-frame off the bow of the cutter head and you can see here this is the ladder I was talking about and it terminates in the cutter head.

This is the cutter head motor, the cutter head shaft and what she's going to do is we'll take a look first at the - this is the cutter head with these removable pick points that they like using up in the relatively consolidated sands up in St. Paul.

But it's just rotating the cutter head and suctions located right down here. And like I said, the cutter head function is to dislodge the sediment and feed it into the suction point.

And what she'll do, she'll lower that down into the water and she'll start here centrifugal pump open. Like I said, remember you think hydraulic dredges, think pump. Like Huston said, that's the heart of a hydraulic dredge.

So you've got (impeller) inside rotating, spinning around. The dredge sediment's coming through the suction line. This (impeller) is swinging the material out, transforming the centrifugal force into the velocity head that's required to force the material to slurry out through the discharge line.

And here's just a picture of that impeller. It's a shrouded three runner vanes that would rotate in this direction. The sediment would come in through the inlet and these veins would throw that material out against the volute to force it in and down through the discharge line.

So our lever woman will look out and she'll see, okay, her anchor barges, they'll be putting down the anchor, setting the anchors. She'll crank up her swing motors and start taking in, like I said, taking tension on one side, release tension on the other side and she'll start swinging.

Now, the slurry's going through the pipeline. We're looking after the dredge into the discharge line. And I just wanted to point out on the other graphic of the cutter head, we had a conventional dual spud arrangement.

This is a spud carriage and the working spud is down in the slot that's where the dredge can push against that spud, hydraulic ram or electric motors and

that'll help advance the dredge in a more efficient way and like these dredges with the spud carriages, you can increase your efficiency by about 20% with these carriages.

So we're going - we're advancing into the material. We've got now a slurry density happening. It's going out through our floating line on this pontoon out into the scenic background into the Upper Mississippi River around (Winona). And you can see the material will be flowing through our float line over - floating line over to the shore where naturally it turns into shoreline.

And we go from a steel pipe to an HDPE pipe. It's a lot more flexible. It's easier to maneuver in conditions like this and what we're seeing here is some examples of dredge plant or plant, backhoe, cherry picker, dozer. These types of equipment are necessary to support the function of the dredge.

And this is the money shot. The slurry's coming out, placing sand at the top up in, and again, as I said, scenic Wisconsin. And again, multi beam, full coverage at the bottom. You see toes of the channel. You can see that arch of the cutter head dredge as it advances into the sediment.

And you can see like a little wind rows. It won't take everything out, and again, like I said, no dredge excavates a flat bottom. They all have to dig just a little bit deeper in varying degrees depending on the type of dredge and which area you're digging in but they have to dredge a little deeper to attain that required depth for you.

And then as we saw, types of discharge line. Here's some steel pipe, floating line on pontoons and it transitions into floating line that's a rubber hose in the case of some buoyant material and I've actually seen about a 50 foot shrimper

go over one of these floating hoses and all it did was it (frayed) the outer surface.

It's really tough but also relatively expensive material. So then we went to the shoreline and in this case instead of HDPS pipe, we've got steel. And then in some cases to keep it out in navigation way, you can place the pipeline on the bottom of the waterway and as you can see, with the submerged line.

And these are just the traditional hydraulic placement mechanisms along shore, open water, upland. And, just with these - where you can get the pipe, you can put the material down.

And this is an example, like, say in the Mobile district where Mobile Bay, in recent history they've used the hopper dredge to take the material offshore and place it in the offshore, where they're trying to get back to use materially and beneficially place it inside the harbor because the bay is becoming sediment starved so they're investigating a thin layer placement.

They'll not only renourish the sediment budget inside the Bay but subsequently also reduce their - the cost of their dredging. And we'll go on to the next. Now the hull pump or ladder pump will only get you so far. And if you have to pump the material a longer distance, you'll start to include booster pumps.

Basically you can pump farther. And here's just an example of Great Lakes pump station on jack up barge or a GIW pump that's out on the land base. And in today's environment, like, let's say Louisiana, they're losing a football field size area of coast every hour. They are seriously investigating long distance pumping especially with the BP money starting to hit.

Like, Great Lakes dredge and dock just did about an approximately $50 million project where they restored Scofield Island with material with sand pumped from the Mississippi River and they pumped that sand about 23 miles to do it and they successfully conducted this program.

And that sand particle was in the pipeline for approximately 2-1/2 hours and the project was a success and the state of Louisiana is looking more and more into this long distance pumping technology to help them restore their eroding wetlands.

Another way to discharge or replace the material is - here is called a spider barge. It kind of looks like a spider in all this water. I don't know where you're from, if you've ever seen a water spider but they skitter across the top of the surface.

Well, the spider barge with these discharge Ts, here you can see the pipeline from the discharge line of the pipeline dredge comes out to here and it'll flow in from these Ts, discharge Ts and the function of the discharge Ts is to distribute the sediment and slow down the velocity so it enhances settling inside the barges.

And then, so you're transitioning from a pipeline dredge into barges so now you can take and barge that material off longer distances at a great economy.

Advantages Cutter heads, can excavate most types of material if it's within distance. You can place the material directly into the placement site and once you're set up with your pipeline it's almost continuous dredging and it's often the least expensive if, again, you're within the pumping distance of the placement area.

Limitations - limited safe operational ability and waves. We start to get two, three, four foot waves or, start to stress out the ladder and the trunnions connections to the hull, it becomes not a good situation.

They're not self-propelled so they need a tug to get them to and from the site. And when they're pumping, they'll add, like, 3 to 10 parts of water to 1 part dredge material and so given this - and remember what I said about the mechanical dredge - basically a general rule is the mechanical dredges are - they're more turbid, more sediment resuspension at the dredge site but less at the placement site because more consolidated versus the pipeline dredges are basically less turbid, less suspended sediments at the dredging site, more resuspension at the placement site because of this 10 parts of water to 1 part dredge material or you can say 10%, 20% solids by weight, if your mind thinks that way.

With the pipeline and anchor barges, et cetera, you can interfere with navigation and you can get debris in the pump and clog it up. I already talked a little about the Corps developing a dustpan dredge. It's named after the - it looks like the dustpan you clean up the floor with the broom.

How this dredge works, is it'll use the dustpan and it'll suck the material through the suction line and through the dredge and how it advances is what they'll do is they'll go upstream and they'll deploy a port and starboard hauling cable and they'll generally cross these cables.

But then they'll back down and they'll lower the drag head into the material-scratch that lower the dustpan down into the material and advance into it hauling in the hauling cables.

And these types of dredges use a high capacity but a relatively low head pump because they generally only pump the material through about an 800 or about a 1200 foot discharge line.

And again, here's just an example of a cartoon of the dustpan advance and these dustpan dredges use a jetting array that forces a water jet into the sand. This is in the sediment and will fluidize it and then that enhances the production rate of the dredge.

And we'll take another tour this time on the (Jadwin) of the Vicksburg district. And here you see the head log or that's the foremost point of the dustpan dredge. You see the - and personnel will, when the dustpan gets clogged up, they'll clean out the clogged pans from the head log.

But something to note is you see these knotted ropes going down into the water. They're called Jesus ropes because if you manage to get in the water and if you don't grab one of these ropes, only Jesus can save you and you start to get into there because these dustpan dredges can work up into five, six, seven knot currents.

Now we'll be looking here from up in the lever room. These dustpan dredges are self-propelled. And if you look out forward through the windshield, you're looking down at the A frame that supports the dustpan. And here we can see the suction line and that water jetting. Right here is the water supply pipeline going to the dustpan forward of the dredge.

Here's that hydraulic heart of the dredge, start up the hull pump, and just to give you an inkling of the - an indication of the size of these hauling winches, here's a doorway, so these hauling winches spools are taller than a man or a

woman and they'll drop the dustpan in the sediment and start hauling in these haul cables, moving forward and advancing into the face of the sediment.

Then looking stern of the (Jadwin), like I said, these things - these dustpans traditionally will pump through about an 800, 1200 foot discharge line and out to the discharge and what they can do at the discharge, is they have a deflection plate that they can modify the direction and the motion of the (determinates) of the discharge line by varying angle of that defection plate into the slurry flow and steer it by the reaction forces.

Dustpan dredge advantages - they're self-propelled, mobilize relatively quickly and get out of the channel traffic relatively quickly. That short discharge line pumped directly to the placement site.

Once it's set up, it can almost continuously dredge and because they'll advance along a reach, they can start in the middle of the channel and do a long reach and they can start opening up that channel to navigation quicker than, like say, a cutter head or a mechanical dredge because that mechanical or cutter head dredge starts at one end and starts to work through that reach as opposed to transversing longitudinally during its operational methodology.

Limitations - limited safe operational capacity and because they're build specifically for operation in the Mississippi River. There was the BeachBuilder - had a higher freeboard and could handle a larger waves but I think she still oversees.

And, again, they were designed basically for unconsolidated material. They have that short pumping distance and debris can clog up the pump or the pans and reduce your efficiency. Next we'll be talking about the hydraulic, another hydraulic dredge, the hopper.

Julie Marcy: Tim, this is Julie. Just a time check for you. It's about 20 before the hour so we just need to allow for our Q&A time.

Tim Welp: I've got about another couple of minutes and we'll go through here. All right, and here's the hopper dredge. It'll suck materially up through the drag head into the hopper, through the pumps. Fill the hopper up, load up, raise the drag heads, take the material offsite.

Just a fast cartoon, again, about how these drag heads are dragged longitudinally through the channel. Here is the hopper dredge Essayons from the Portland district, the flying bridge of the dredge.

The drag tender sits down in the cockpit. This is a vast array of instrumentation he uses to dredge. Here's looking out over the hopper, the dustpan, drag pipe goes over the side. The drag head will go down.

Here's a picture of it underneath and you can see the sand blast from the sand. It gives you that shiny coat. Here's a multi-beam and you can see it excavates in the troughs. You can discharge out of the split hull, bottom dump door.

Or they can tie up to the floating line and discharge it to the shore or pump it out through a rainbow nozzle. The disadvantages - I'll just kind of briefly hit the high points but there's the only dredge design for rough open water and they can't work in shallow depths.

And they have difficulty in dredging hard banks and consolidated material. This is a variant of a hopper dredge side caster. It's kind of like a hopper dredge without a hopper and it'll pick up the material through the drag heads

and it discharges off to the side through the side caster and they're basically designed to remove (bar) channels in small coastal inlets.

And we also have special purpose dredges that are split hull used drag heads and we use the dredges Murdan or Currituck on these projects where we can get in close to shore and dump the material in the littoral zone to get the beneficial uses that I was talking about earlier.

Water injection dredge, it's - you kind of have a hydraulic dredge but now we're starting to get off in the non-conventional types or you jet water down into the bottom of the channel and you create a density current and this current will flow downstream into the deeper spots.

And because you have less plant, you can get less costs and the right types of material, you can get up to about 2000 cubic yards an hour. But, of course, you can only work where in water placement is allowed - since you don't have any equipment in the sediment, you can work around utilities safer but, of course, you cannot use it in contaminated sediments where adverse impacts can occur.

Now generally are some high spots around and a bed lever is just a plow or a bar that's dragged over the high spots to move the material into the low spots and used to clean up materials.

And this is just an illustration to start to illustrate how the large number of different technologies, methods that these dredges can uses to place materials in different spots.

Something you can look at later, in your area, wherever you're from what kind of dredges are being used. And then the last slide, and this is - I

wondered about putting this in but I just wanted to give you an order of magnitude.

Like I said, if you get three dredgers sitting down at a table, you're going to get four opinions but just to give you an idea of what (Tom) said about dredging is it's a $1 billion a year industry. Big hopper dredges can really approximately cost around $90K to $100K. The cutter heads, $50K to $100K, mechanical dredges from $40K to $75K. And that's just the orders of magnitude. The end.

Julie Marcy: That's great, Tim. This is Julie. Let me go ahead and unmute everybody so you'll be in interactive mode. Depending on the type of phone, you may still need to hit the mute button or star 6 to unmute.

Operator: All participants are now in interactive talk mode.

Julie Marcy: If anyone has a question for Tim, you're welcomed to ask them either verbally or using chat. He gave us a great overview going back through the millennia. Excellent job there, Tim. So we'll open it for questions.

Tim Welp: And at the very least, somebody please tell me, should we use the term dumping or not to dump.

Julie Marcy: Okay, to dump or not to dump.

(John Childs): Well, Tim, this is (John Childs) and that was a great presentation. I'll suggest for the dumping versus - to dump or not to dump, is that under MPR, I'd say the regulations associated with that 40CFR227 regs clearly does include the term dumping.

And MPRSA is sometimes referred to as the Ocean Dumping Act, so I don't think we really have a choice but to keep it and I think it's from a field perspective, as you point out, it's perfectly legitimate. What I would suggest is that when...

(John Childs): I would suggest that we include intent for placement, so a dredge will have a, as you pointed out, the placement or discharge phase. And during that placement or discharge phase, we have intent. We have intent for either disposal or intent for beneficial use.

Because the beneficial use, there are times, again as you mention, the littoral , placing material in the littoral system, flowing placement, side cast, sometimes that is of beneficial use and so we haven't really always considered that beneficial use by keeping the sediment in the system as a natural resource is a benefit. So I would suggest that the placement phase we have intent for either disposal, which is rare, or beneficial use, which is common.

Tim Welp: Thank you for that clarification and now I feel more legal with the term dump as well.

Julie Marcy: Tim, this is Julie. I had a question come in on chat. Looking at the last slide, a question is, is that an attempt to make a semi self-propelled cutter head dredge on the last slide?

Tim Welp: Oh, that's a pleasantly twisted question. Thank you.

Julie Marcy: We've got another question that came in on chat. How often is the choice of dredge selected on federal channel dredge projects influenced by sediment contamination level or concerns regarding remobilization of contaminants?

Tim Welp: Maybe you could say I know of certain districts that will, like, when they use - on that one slide where we have the different types of dredges. Am I still on?

Julie Marcy: It's showing the map of the US with the type of dredging.

Tim Welp: Okay, right. So I mean, where we can get some of these areas that have, like, more bucket dredging. In some of these districts where they have had issues raised from sediment resuspension, I know of some districts that have actually required an enclosed or environmental bucket be used in lieu of an open face clamshell bucket.

Like I said, the vast majority of material that we dredge is uncontaminated, the 3% to 5% (Joe) talked about that requires special handling.

(Jim McCann): Tim, this is (Jim McCann) from the environmental branch of Jacksonville district. I have a question. What percentage of projects are not specified in the contracts? In other words, it's very, very - you said, I'm sure, but it's very, very seldom that we specify a contractor to even use a type of dredge. Is that the same for all Corps dredging districts?

Tim Welp: What I've seen is that the different districts have approached that question in different ways. Like around the Gulf states where they'll - they will specify or they - or it depends on the type of rental - or contract that you're using, too, of course, because in a rental contract where they will mandate performance levels of different types of plant.

And, like say, in New Orleans, if Head of Passes, they have to - they specifically require hopper dredges around Head of Passes because the pilots don't like cutter heads around the bends because they feel it's a hazard to

navigation so in cases like that, the districts do require a specific type of dredge and, in turn, require a specific size.

Like out in Portland, where the Columbia River bar, they have to have the dredges powerful and big enough to be able to handle those rolling breakers offshore. So I'd say - and I'm not really a contracts based expert - but I hope that answered your question in some manner. Or if not, I can talk to you offline and get you connected to some of the (onsite) people.

(Jim McCann): No, I kind of see where you're headed. If there's a good reason for selecting it, then they do. Otherwise it's pretty much open.

Tim Welp: I can say this - is that if you are going to mandate a specific type of dredge or a specific size of dredge, you better have - you have that decision scientifically defensible because you'll have a contractor out there that's going to protest for sure.

Julie Marcy: Tim, this is Julie. I had another comment and question come in on chat. One, an appreciation for the history of the dredging slide and information. And then the question is, where do you see dredging equipment and methodology going in the next 10 to 20 years or perhaps beyond that?

Tim Welp: Well, as a mining engineer, at one time they were looking at nuclear explosions to break rock but I don't think that will go that far. What we are seeing is, like, the largest hopper dredge we've got right now - and I showed the different types of the split hull, or the bottom dump hoppers.

But currently Great Lakes is building, I think, what, the (Glenn Edwards)'s 12,000 cubic yard hopper dredge up on dump door, but Great Lakes is currently building an articulated tug barge configuration where all the

hydraulics are on a barge, drag heads to pumps, everything and this articulated tug will come in.

It's kind of like a quasi-mechanical dredge barge and a hopper dredge where the tub will come in and actually interlock like a male, female fitting. It'll link to the barge and they'll use that to dredge. I don't know what the specific - what the status of this is but these kinds of technologies, I think the Europeans have investigated this but Great Lakes is going out to advance the development of this type of methodology - is another way that demonstrates how the state of practice is changing in the future for this as well as with the carbon footprint issues.

Possibly more electric dredges and we're also, like, liquid natural gas, we're kind of looking at some of those applications for the prime movers, like, we changed from manpower to horsepower to steam power to diesel. Maybe even in future we'll be doing different energy sources as well.

Julie Marcy: Any other questions for Tim, either verbally or using the chat? There's - one question had come out on chat. Will the presentation be available for download? Yes, on the DOTS Web site, that was on the introductory slide, we will have a PDF of the Power Point available for download and we'll also have the recorded video and then a written copy of the transcript of the audio portion.

If you need the DOTS Web site , just send me, Julie Marcy, a note and I'll send you the URL for that or I can enter it in chat if folks need to see that again.

Any other questions for Tim? Tim, thank you once again for an excellent presentation. You really covered a lot of territory. I see that (Cynthia Banks)

has been kind enough to enter the DOTS URL Web site into chat for us. So you can take a look at that.

And I appreciate everyone joining us. We have folks from all corners of the United States plus some industry and other federal agencies partners and we're very happy that you were able to join us. And, Tim, thank you once again, for an excellent presentation. And with that, we'll conclude our session.

END